ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR

OF THE

STATE OF NEW YORK,

FOR THE

FISCAL YEAR ENDING SEPTEMBER 30, 1896.

TRANSMITTED TO THE LEGISLATURE FEBRUARY 8, 1897.

WYNKOOP HALLENBECK CRAWFORD CO.,
STATE PRINTERS,
ALBANY AND NEW YORK.
1897.

STATE OF NEW YORK.

No. 73.

IN ASSEMBLY,

FEBRUARY 8, 1897.

ANNUAL REPORT

OF THE

STATE ENGINEER AND SURVEYOR.

ALBANY, *February* 8, 1897.

To the Honorable the Speaker of the Assembly:

SIR.— I have the honor to transmit herewith my annual report for the fiscal year ending September 30, 1896.

CAMPBELL W. ADAMS,
State Engineer and Surveyor.

REPORT.

Probably for the first time in twenty years at least the annual report of this department can be left comparatively free from those disagreeable fault findings and predictions of disaster to the canals, the State and its commerce that have heretofore characterized these reports, because of the apparent lack of appreciation of the importance of the canals to the material interests of the State, and, in sequence, the appropriations for their maintenance and improvement, both so miserly and inadequate that they have utterly failed to accomplish any of the results sought for, until at last it seemed as though these once all powerful, but now weakened, arteries of commerce were doomed to succumb to the machinations and potent influences of their more modern competitors, which seemed to have been able, under existing conditions, to render the canal business no longer profitable to any one concerned. The most unfortunate outcome of such a condition is the diversion to other routes and destinations outside this State of the commerce that had so largely aided in placing our State foremost in all that pertains to wealth and importance and their attendant blessings.

The good sense of the whole people can usually be depended upon to accomplish the right thing, and they certainly made no mistake when, by their ballots, on November 5, 1895, they recorded their decision that the State's canals should not only be main-

tained, but that they should be improved to such extent as might be possible by the expenditure of $9,000,000.

Right here it seems but proper to say that while it is believed that this sum can be made to suffice for the work of simply deepening the canals to the required depth, it does not follow and it is not true that it will cover all the work now required to put the canals in the best possible shape.

There seems to be a popular opinion in the minds of many of our citizens that no improvements to our existing canal system less radical than the building of a ship canal will enable us to regain and control the enormous freight traffic of the Northwest, to which our geographical location and resources would seem to entitle us. In this opinion I have never shared, because at best it would be an enormously costly experiment, and would take many years of time for its consummation, and, in the meantime, with the ever-changing development and growth of other routes, methods and conditions, it is by no means impossible that the transportation problem, so far as any canal across this State is concerned, may have undergone a great change.

The real condition now is that our present canals are not adequate to handle the business which naturally should seek them, and what little business remains, is handled in a decidedly unbusinesslike manner. There could be but one result from such conditions and the constantly dwindling canal business and the attendant alarming reports of the falling off of business at the city of New York, and the correspondingly increased business or other ports which are in a position to handle the northwestern freights, form the sequel of the story.

If, then, we are to regain and control this business, as all believe we should and can, it seems to me to be of the first importance

that we should adopt a remedy that can be applied quickly and at conservative cost.

That we have such a remedy at hand by improving our present canals to the maximum possible extent, without radically changing their routes or structure, is my earnest belief, but it is also my duty to state that this can not be done, and is not contemplated, under the present so-called "nine million dollar improvement."

Briefly, this improvement authorizes the deepening of the Champlain canal from its present depths of five and six feet of water to a uniform depth of seven feet; the Erie and Oswego canals are to be deepened from seven to nine feet, "except over and across aqueducts, mitre sills, culverts and other permanant structures, where the depth of water shall be at least eight feet * * * ; also the lengthening or improving of the locks, which now remain to be lengthened * * * ."

This improvement of the Champlain canal, and possibly of the Oswego canal, will doubtless suffice for all present needs, but it will not and ought not to suffice for the Erie canal, which must meet very different conditions from the others. As a means of increasing business and profits, and decreasing rates, the proposed improvement of the Erie canal will simply mean that two boats can pass each lock without disconnecting, and that each can draw one foot of water more than at present, which with the principal articles of freight, would mean a possible additional 50 tons to the present load of 250 tons of paying cargo. The added speed made possible by the deeper water would doubtless be consumed in hauling the additional cargo. In other words, this means a possible maximum increase of paying cargo of 20 per cent.

Let us now see what might be accomplished by only slightly enlarging the scope of the present improvement. First, let us obtain

nine feet of water, for the entire Erie canal at least, instead of this depth simply between structures. This would add another foot to the contemplated available draft and 50 tons more to the paying cargo. To do this, it will be necessary to lower the mitre sills, and in some cases the floors, of part of the locks, but as many of them are already low enough, and as the 16 locks at Cohoes, 4 at Little Falls, 3 at Newark and 5 at Lockport, 28 in all, are to be lengthened and remodeled under the present improvement, the cost of fixing the others would be comparatively small.

Another great improvement can be made at small cost and should by all means be made. I refer to a modification of the locks other than the 28 above mentioned, so as to enable them to pass two boats together, each about 115 feet long instead of 98 feet as at present. The present mitre gates require about 12 feet of the space within the lock chamber for their operation. By substituting a different form of gate, in some cases at the head of the locks and in others at the foot, this space and enough more could be saved to admit the passage of boats 115 feet long, without radically changing the present masonry-walls, and at a cost of about $8,000 for each lock. Boats of this length can be operated without difficulty, and the idea is exceedingly popular with the boatmen, who see it in the certainty of an increase in paying cargo of 17 per cent., with only the slight additional resistance to propulsion occasioned by the friction on the added length.

This increase of cargo added to the 100 tons made possible by *two* feet greater draft than at present renders it possible to carry a paying cargo of say 410 tons, or an increase of 64 per cent., as against a possible load of 300 tons, or an increase of 20 per cent., under the plan now authorized and contemplated.

By installing the proposed mechanical lift-locks at Cohoes, Little Falls and Lockport, it will doubtless be possible to save sufficient time over present methods to admit of making the present number of round trips with such increased loads. With the accomplishment of all these gains, we should have a truly comprehensive improvement at comparatively slight cost, but yet rendering it possible to make ours the cheapest and most desirable route from the Great Lakes to the seaboard. We should be content for the present at least with such a result and thereafter, if it shall develop that a ship canal is essential to the best interests of this, as well as the western States, which now produce the principal canal freights, we will at least be in a good position, pending the necessary research and study which certainly ought to precede the undertaking of such an expensive experiment.

The prospects for a great increase of canal business to follow the improvements now being made, look very bright, and beyond a doubt, the expenditures now being made will soon be proven to have been a good investment by largely increasing the business handled within this State. Such business naturally tends toward the enrichment of all the cities and towns along the canal but particularly of Buffalo and New York. All additions to the taxable valuations of these places is a direct help and relief to the less fortunate localities. Unless the views and aims of all who have ever sought to make our canals an important factor of our material welfare are totally misunderstood by me, the first object aimed at has been the enrichment of the State and secondarily the enrichment of the boat-owners and others engaged in handling the canal business. That has been the object of our canals as well as of all others that have ever been built anywhere. When our canals were first built they handled practically all the freight

business across this State. Then followed the railroads and as a result of their competition, the volume of canal business has steadily declined, especially during recent years or since the railroads have been brought to their present state of efficiency. Yet in view of this wonderful railroad growth and development, is it not remarkable that the canal still offers the cheapest freight rates from Buffalo to New York and that notwithstanding this well known fact, the canal business steadily declines? The volume of business is greater to-day than ever before, yet the portion of it that the canal handles grows less annually in spite of its cheap rates and the railroads, Canadian canals and Mississippi routes which handle the balance of the traffic are certainly taking a large amount of it to points outside of New York State and it behooves us to find out how this is accomplished. Does any one doubt that it is due to perfect organization on the part of the railroad companies and to the woeful lack of organization among the canal interests? Parties who should be well informed as to the efforts that have been made to organize the New York State boatmen tell me that every effort to that end has signally failed. Year after year we have heard the statement made before the various Legislative committees that the crying need of the canal interests was a State elevator at Buffalo. The railroads did not need any such assistance to make their business successful and the canal interests should not have required it, but should have organized themselves into an effective body and built and controlled such an elevator for their better protection and profit. Instead of making an attempt now toward better organization, we find the peculiar condition of the boatmen opposing the first apparently successful effort in that direction that has ever been made. A company has been formed which aims to largely increase the busi-

ness, especially of the Erie canal. The first stumbling block for this company to remove before its operations can be carried on on the large scale contemplated, is a State law which limits the amount of capital stock of canal transportation companies to $50,000. This would not cover the cost of one fleet of boats, and unless this restriction is removed it virtually means that no large and successful company is to be allowed to do business on the State's canals, if the short-sighted opponents of this company can possibly prevent it. Many ridiculous statements have recently appeared in the public press regarding the probable effect of this company's business on the interests, not only of the State, but of the individual boat owners. The question would therefore appear pertinent as to whether or not the people of this State are spending their millions to improve the canals for the benefit of the whole State or for the benefit of a few hundred boatmen. Why not permit a trial of the same methods on the canal business that have been so successfully applied to the railroad business? Has any one ever suggested that the capital stock of any of the railroads engaged in handling this traffic be limited to $50,000? Of course not, for they could not be useful to anyone on such a basis.

The State always has the power to right or redress a wrong, and if it shall appear later on that any privileges granted to the company in question, or others of a like nature, shall have given them any monopolistic rights that are detrimental to any considerable number of our people, it will be time then to interfere with their operations.

Remove all obstructions to free competition and I predict that if this be done, such pleasing results will follow that the question of the rights and privileges of the individual boatmen will soon sink into insignifiance from the fact that the canals will then have

many times the volume of business that can possibly be handled with the number of boats now in use.

PRESENT CANAL IMPROVEMENT.

The improvements authorized to the Erie, Oswego and Champlain canals by chapter 79 of the Laws of 1895, are now under way and making fair progress, and though such contracts as have been awarded were awarded after the close of the fiscal year covered by this report, a brief outline of what has thus far been done may not be amiss here.

The surveys of the entire work, covering the 38 miles of the Oswego canal, 65 miles of the Champlain canal and 351 miles of the Erie canal, a total of 454 miles, were started January 13, 1896, which was as soon as we could be assured by the Comptroller that funds for the prosecution of the work would be available. The work was divided into 28 survey sections, and over 200 men, selected from the Civil Service eligible lists, were assigned to the work, in order to hasten the completion of the entire survey and the compilation of all data necessary for the preparation of all plans prior to the opening of navigation. This result was accomplished, though the great extent of the work and the unusually severe winter weather made it extremely difficult. Our forces were then largely reduced, and the preparation of careful plans, specifications and estimates to form the basis of future contracts was begun. The plan adopted by the Legislature for this improvement had been discussed for a number of years, though in a decidedly unscientific, if not unbusinesslike, manner, as no means had ever been available for the collection of data either for the preparation of plans or as the basis of an estimate of cost. This much-discussed plan was known as the "Seymour plan," which,

in a general way, contemplated the deepening of each of these three canals two feet, by raising the banks one foot and lowering the bottom one foot, or wholly by lowering or raising. At first glance this would seem to involve very few problems of a serious nature, but, as a matter of fact, many problems have developed that have required many months of conscientious study and research for their proper solution. One of the first of these was to determine the proper increase either of depth or width of the channel, known as the "lake level," extending from Lake Erie to Lockport, 28 miles, through which the canal must necessarily be fed, as far east as Montezuma, or over 150 miles from Lake Erie. The unknown quantity of the amount of additional filtration that will surely ensue, the disturbance of the present bottom of this length of canal, which has become securely "puddled" or water tight by natural and artificial means, after seventy years of use, was, of itself, a very serious matter, and the same problem presents itself in many other places. It was decided to make a thorough investigation of the problem of water supply from Lake Erie and the proper size of channel through the rocky summit just west of Lockport, and to that end Assistant Engineer George W. Rafter was directed to make the necessary surveys and report, and reference is hereby made to Appendix I of this report for detailed information on this subject.

The next problem of importance was to settle on definite plans for the improvement through the cities and more important towns. Here the first difficulties are found in the bridges and their usually steep approaches, to raise which would mean, in many cases, dangerously steep grades, and in nearly every case probably serious claims for damages from the owners of adjoining property, which would, doubtless, be injuriously affected. Between these

streets and bridges, along the banks of the canals, important commercial establishments have grown up, with their buildings adjusted to the present canal grades, and, therefore, any raising of those grades becomes a very serious matter. On the other hand, if the improvement be made by deepening, we encounter the liability of flooded cellars, and consequent claims for damages, especially since it is true that much of the canal bottom through these cities and towns has been made water tight only by the use of artificial appliances and at great expense. However, in most of these cases the apparent great importance and cost of raising these bridges and their approaches, often entailing other serious difficulties, have moved us to decide to improve most of such levels wholly by deepening.

In many cases the decision as to obtaining the additional depth of water by raising or lowering, or both, is fixed by the levels of the feeders and the heights of the dams which regulate them, without regard to comparative cost. In other cases the work, cost and other considerations regarding the changing of large and important structures, such as the Upper and Lower Mohawk aqueducts, the Rochester aqueduct and the Montezuma aqueduct are the controlling features in determining the new grades.

The preparation of suitable specifications to guide and direct the work and provide for the innumerable contingencies incident to such a large undertaking and which should comply with all the laws governing State work and also protect beyond peradventure the interests of all concerned, was of itself a work of no small magnitude. The study and judgment of the heads of the several branches of this department, and of some of the more experienced assistant engineers has been conscientiously devoted to this important subject and a specification has been evolved which it is

intended shall cover all work incident to the improvement, thereby placing all the contracts on a uniform basis in this respect. The operations to date under these specifications seem to be mutually satisfactory, and it is my earnest hope that no difficulties will arise thereunder, which can not be equitably and amicably arranged without recourse to the board of claims.

This outline of the difficulties involved in planning this work will convey a slight idea of the problems that have required solution and show to any who feel that the work is not making proper headway, some reason for what they may consider undue delay.

The work is well under way and the completion of the plans and estimates for the balance of the work will follow very soon, to the end that all of the contracts may be awarded early during the following season, and in time to allow the contractors to deliver the necessary stone, cement, timber, etc., by canal during the summer months, so as to be in readiness for an active season next winter.

A comparatively small portion of the several canals can be improved by dredging, during the season of navigation, and such portions as are susceptible of being handled in this manner, will be put under way during the coming summer.

Up to date, 12 contracts have been awarded on the Eastern Division, covering about 42 miles, 16 of which are on the Champlain Canal. The estimated cost of this work was $1,083,650, while the total cost at contract prices will be $983,725, representing a saving of $99,925 over our estimates.

On the Middle Division 17 contracts have been awarded, covering a distance of 27 miles, three and one-third of which are on the Oswego Canal, and the improvement of 11 miles more of this canal will be practically completed by the raising of four of the Oswego

River dams, which are included in the above mentioned number of contracts.

The estimated cost of this work was $1,056,364, while the total cost at contract prices will be $944,153, representing a saving of $112,211 over our estimates.

On the Western Division five contracts have been awarded, covering the 31 miles from Lake Erie to Lockport complete, besides 17 miles covering the level from near Rochester to Macedon, or a total of 48 miles.

The estimated cost of this work was $1,270,958, while the total cost at contract prices will be $1,100,847, representing a saving of $170,111 over our estimates.

By way of recapitulation then we may say that 34 contracts have been awarded, covering 117 miles, at an estimated cost of $3,410,-972, but which will cost at contract prices $3,028,725, representing a saving of $382,247 over our estimates, which are thereby proven to have been uniformly conservative.

It should be stated, however, that while in a few cases the estimated quantities of work will be exceeded, it is also true that since awarding the contracts we have ordered many large items of work to be omitted, that it was originally proposed to do, and therefore a considerable saving over the above figures may be confidently expected.

It should also be stated that many of the above contracts cover those sections of the canals which offered the greatest obstacles to satisfactory navigation now, and being in the worst condition they are naturally more expensive to repair and improve than the balance of the work. A culling-out process is now being applied to the work for which contracts are yet to be awarded, and every item of work or cost that can reasonably be omitted will be stricken out,

with a view of keeping the total cost within the appropriation, and while it is impossible to state definitely at this time, whether or not this can be done, the best energies of this department are pledged to its accomplishment if it be possible.

In my last annual report considerable space was devoted to the matter of amending the "Canal Improvement Law" (Chapter79, Laws of 1895), so as to dispense with the provision requiring lump sum bid for the work to be done, and also to the matter of shortening the time required for advertising from six weeks to a minimum of ten days, though really leaving the duration of time for advertising, as well as the designation of the papers to contain the advertisements, optional with the Superintendent of Public Works. My thanks are due the Legislature of 1896 for its attention to these matters, which were crystalized into the form desired by the enactment of Chapter 794 of the Laws of 1896.

This practically places these features of the work on the same basis as all other work and in conformity with the routine that has been in vogue for many years and found to be thoroughly satisfactory.

A great saving of time and money will ensue, and the results in connection with the contracts already awarded demonstrate that the means adopted are adequate to the desired ends, and that all interests are thoroughly protected.

BLANKET APPROPRIATIONS FOR CANAL REPAIRS.

Chapter 947 of the Laws of 1896 appropriated $125,000 for each of the three canal divisions, to be expended at such places and for such purposes as the Superintendent of Public Works and State Engineer and Surveyor might deem for the best interests of the

State, all plans and expenditures being first approved by the Canal Board.

I can not speak in too commendatory terms of this method of providing for such work. Aside from the fact that it would undoubtedly have been impossible to have secured a sufficient number of separate appropriations for the various pieces of work that have been covered under the chapter in question, this law has resulted in giving the departments charged with the responsibility of maintaining the canals, the sums required for the work, when they were most needed, and the usual condition of having less money than was actually required for one piece of work and more than was required for another piece, has been avoided. The great bulk of work accomplished under the law in question was of a nature which it would have been hard to define under separate laws, except in the most general way, and all of this class of work has been badly neglected for many years.

On the Eastern and Middle Divisions especially, the waterway under almost every aqueduct and through many of the culverts was seriously obstructed by deposits which have been accumulating for many years, and which were in such a serious condition as to endanger these structures and the navigation of the canals in times of flood. Many instances could be cited where by reason of lack of attention to these matters serious claims for damages have been before the Board of Claims, and in many cases the damages that have been collected would have more than paid for removing the cause of same.

There are many miles of the canal banks where it seems to be impossible to stop leakages that are of so serious a nature that if the leakage is not collected in ditches, it becomes a serious damage to adjoining lands. Through lack of available funds for this

work these ditches have been neglected for a great many years until the past summer, when the worst of them were again put in condition to serve their proper purposes. This will be the means of stopping many more claims for damages against the State.

Nearly all the reservoirs which feed the Middle Division of the canals are located at almost inaccessible points in the Adirondack wilderness, and these have had practically no repairs whatever for many years. Many of the dams connected with these reservoirs, are built of earth or timber, and continued lack of attention has placed several of them in an extremely critical condition while the controlling works connected with each were found to be antiquated, dilapidated and without proper safeguards to their manipulation, the result of the latter situation being that in many cases the lumbermen have used the supply of water to their best interests without regard to the State's rights or the needs of the canal.

The fact that these reservoirs are located in the heart of the Adirondack wilderness, where few people could see and appreciate their condition, and where it was a serious task for the canal officials to undertake to visit them frequently, probably accounts in some measure for their present condition. A great variety of work has been done in connection with them during the past summer, and it is safe to say that they are in better condition to-day than they have been in 30 years, but a great deal of work is still needed.

In the annual report of Division Engineer Gere—which is hereto appended—much information will be found as to the needs and condition of these reservoirs. They are absolutely essential to the navigation of the canals, and the fact that their inaccessibility renders any work done in connection with them very ex-

pensive, is one of the best reasons why the next appropriation of this sort—part of which should be devoted to this purpose—should be of goodly proportions.

In the opening pages of this report, I have stated that all the work that should properly be done to place the Erie canal at its maximum of efficiency, could not be done with the funds provided for the "nine million dollar improvement."

Many structures have been found which must be repaired or rebuilt before the enlarged Erie canal will be possible, and as it was not strictly expected that these would be repaired or rebuilt from the "nine million dollar fund," many of them have been repaired or rebuilt with the funds provided by the Blanket Law in question. Several of these structures happen to have aqueducts which were in an unsafe condition to carry even the present depth of water, and which demanded rebuilding prior to the opening of another season's navigation. As no other funds were available for this work they also are to be paid for from this Blanket Law, and as the additional cost involved for building these for a depth of nine feet of water (instead of eight feet, as directed by the Canal Improvement Law) is very slight, they will be built for the uniform depth of nine feet of water.

After the close of navigation last fall it was found that lock 96 on the Black River canal must have a thorough overhauling before it could be used for next summer's navigation, and as the work involved would require the entire winter for its completion, it was impossible to wait for this Legislature to make an appropriation for the work. Here again the advisability of having in command funds from a blanket law of this description is demonstrated, for without this work, the Black River canal could not have been operated next season.

Many other instances could be cited to show the utility of making another appropriation of this description, and an inspection of the work done under the law in question during the past year will certainly prove that the work has been economically done and that better results are accomplished from appropriations of this description than with the appropriations made for specific pieces of work as has heretofore been customary.

I earnestly recommend that another appropriation be made of an amount at least equal to chapter 947 of the Laws of 1896, but after three years careful study of the needs of the canals, and especially with reference to what could be accomplished by them for the interests of the whole State after they shall have been improved, I believe it would be wiser economy to make the appropriation for the coming year $200,000 for each division.

LOCK LENGTHENING AND MECHANICAL LIFT-LOCKS.

During the year contracts have been awarded for lengthening locks 21 and 22, which, with the possible exception of lock No. 2 and the three locks at Newark, are the only unlengthened Erie locks which admit of being lengthened in the usual manner. The work on these locks is well under way and they will be ready for use during the coming season. These locks will then admit the passage of boats drawing eight feet of water the same as in the improved canal.

If lock No. 1, at the junction with the Hudson river at Albany, is to be lengthened, it must be entirely rebuilt on a different location in order to permit the ingress and egress of two boats coupled together, either from the canal or the river basin. This would prove to be a very difficult and expensive job and as it is a fact that 85 per cent. of the boats leave or enter the canal at West Troy,

and that practically all the boats using the canal between West Troy and Albany are engaging in the lumber trade and can pass locks 1 and 2 singly without serious detriment, it is at least doubtful whether it will prove expedient to lengthen these two locks, at least until it shall appear certain that sufficient funds therefor will be available from the present appropriation.

The next unlengthened locks are Nos. 3 to 18 inclusive, known as "the sixteens," beginning at the junction of the Erie and Champlain canals and scattered along a tortuous side hill route for three and one-third miles. Lock 18, which is at the head of this series, is almost directly opposite the high falls of the Mohawk river which at this point is very close to the canal.

It is proposed to dispense with this entire series of locks by building a steel aqueduct from the head of lock 18 to a point on the rocky bank of the river opposite, and at the end of the aqueduct to place a mechanical lifting lock that will accommodate two boats at a time and make the whole lift of 140 feet at one spot. It will then be necessary to canalize the south side of the river from this point down to where the Champlain canal now crosses the river, a distance of about one mile, so that the Champlain with the improvements now authorized will accommodate all the traffic of the Erie canal from this point to the present junction of the two canals.

Careful surveys and estimates have been made of the cost of this proposed work as well as of the cost of lengthening the present "sixteens," and even though it were possible to lengthen the "sixteens" and preserve a satisfactory alignment and facilities for getting connected boats in and out of the locks, it will be found much cheaper to put in the mechanical lock as proposed; but it will hardly be possible to lengthen the "sixteens" and leave them

in satisfactory condition for navigation. The estimated cost of improving the present 16 locks and the levels between them is \$1,686,831 and it is certain that the first cost of making the improvement involved with the mechanical lock would not cost more than two-thirds of this sum, and this could be largely reduced if the lands now occupied by the Erie canal over the distance covered by the "sixteens" could be sold and the proceeds therefrom credited to the canal fund.

By this proposed improvement it will be possible to save from four to eight hours time on each trip beside a considerable cost for helmsmen and extra teams that are now required to haul the single boats of each fleet through the "sixteens."

A great saving of water could also be accomplished and as the Mohawk river does not now afford a sufficient quantity of water to run the mills of Cohoes and surrounding manufacturing towns continuously during the summer months, this feature alone would be of great value as the mills could then have the use of the water that would be saved. Moreover an annual saving of \$35,000 in the item of lock tending alone can be effected, and it is also unquestionably true that the maintenance of the proposed new structure and canal would cost considerably less than the three and one-third miles now occupied by the "sixteens."

The scheme presents many desirable features from all points of view, and no time will be lost in putting it into effect.

The next unlengthened locks (four in number) occur at Little Falls, and this situation is now being seriously considered with a view to combining all these locks into one, which can probably be done at a cost about equal to that of lengthening these locks in the ordinary manner, while their peculiar location will render this

latter method of improving them very expensive and probably unsatisfactory when completed.

The next unlengthened locks (three in number) occur at Newark, Wayne county, and here also a change of route will be found advisable if the locks are to be improved. The total lift of the three locks is now approximately 24 feet, and plans are now being considered for combining these into two locks of the ordinary type, and also for a single mechanical lifting lock.

The next unlengthened locks are at Lockport and consist of a series of five which are practically one structure. The lengthening of these locks in the ordinary manner would involve the total destruction of the present locks, and would entail many difficulties and by no means the least of these is the fact that the old work could not possibly be torn out and the new locks built in the five months between the seasons of navigation. No change of route is here practicable and whatever is done must be done almost on the site of the present locks. Moreover the cost of lengthening these locks in this manner would probably be so high as to seem unwarranted in view of the advantages to be gained. For these reasons the first plans for a mechanical lifting lock have been developed for this location, and after a year of conscientious study on the part of this department, aided by the skill and advice of many competent civil, hydraulic and mechanical engineers, we feel that the problem has been solved. These plans are practically completed, and we hope to advertise for bids for the actual construction of same before the opening of navigation.

The great bulk of the work involved will necessarily have to be built away from the line of the work, and all this can progress during the summer months so that the various parts will be ready to assemble the moment navigation closes next fall. The locks could

then be in operation by the opening of navigation in 1898, though if this should be found to be impossible, the plans are so devised that in any event the present locks will not be interfered with and will be ready for service when required.

Three sets of plans for this work have been developed and one of the conditions which all have been designed to meet is that the adopted plan should be capable of economic installation either at Lockport, Newark, Little Falls or Cohoes. Two of these plans provided for suspending the lifting troughs by cables and operating the same by two distinct hydraulic methods, but on the completion of the estimates, the cost of either of these plans was found to be too excessive to warrant their adoption.

The other plan which has been adopted depends upon compressed air for its operations. Owing to the probability that several important features in this plan will be considerably changed before the work is advertised for letting, I do not deem it advisable at this time to go into any detailed description of the plans and method of operating, but prefer to leave the subject until the next annual report in order that it then may be carefully and fully discussed and illustrated. The adopted plans have been prepared by Chauncey N. Dutton, C. E.

STATE LANDS DEPARTMENT.

Since the State Engineer and Surveyor by virtue of his office is one of the Commissioners of the Land Office, all applications to that body for grants of land under navigable waters are referred to this department for examination and report, as are also a large number of miscellaneous matters relating to State Lands. These matters require careful inspection and naturally consume and receive a great deal of time. The maps and papers are examined

to determine their correctness and proper form, both from an engineering standpoint and to insure their conformity to the rules and regulations of the Land Office. In many cases it is also necessary to visit and inspect the locations of the proposed grants to decide as to the advisability of making the grants on the lines of the application, or if necessary have them modified. It is also at times deemed advisable to deny some of these applications on account of interference with navigation, with the rights of adjoining owners, or the rights of the public.

There have been received and reported upon during the past year fifty-eight applications for lands under water, of which fifty were for "beneficial enjoyment," and eight for "purposes of commerce," and situated in the various counties as follows: Richmond 8, Kings 28, Westchester 7, Niagara 1, Erie 1, Ulster 2, Greene 2, Dutchess 1, Queens 4, New York 2, Columbia 1, Albany 1.

The State Engineer and Surveyor is by law directed to sell at public auction all of those unappropriated lands of the State which may be ordered sold by the Commissioners of the Land Office. The records of the office show that during the past year there have been sold 136 parcels of land, situated in 16 counties of the State, and distributed as follows: Allegany 2, Broome 1, Chautauqua 12, Erie 1, Genesee 1, Kings 6, Niagara 5, Oneida 10, Onondaga 1, Oswego 1, Cattaraugus 3, Rensselaer 43, Rockland 11, Suffolk 3, Sullivan 1, Richmond 35. The sum of $11,350 was realized from the sale of these lands. Nearly all of the lands sold were acquired by foreclosure of United States loan mortgages or through the comptroller's tax sales. A great deal of correspondence reaches the Land Department from surveyors, attorneys, real estate owners and agents in all parts of the State, desiring copies of the records, copies

of field notes and tracings of maps, etc., the originals of which are on file in this department. These represent the original surveys of a large portion of the entire State and particularly of the Adirondack section, where the State now has title to many thousands of acres. Many of these records are more than one hundred and fifty years old, and as they form the original description of boundary monuments, they are of great value and importance, and once destroyed can never be replaced. The value of many of these documents is constantly increasing with the growing demands for the acquisition of the remaining land necessary to complete the Adirondack Park.

As is usual with such old records their value is seldom appreciated until time and constant handling have rendered them almost unfit for further use, and the records in question are no exception to the general rule.

Many of them were poorly executed in the beginning; some are on very poor paper, which has grown exceedingly brittle and in many cases of this kind the paper is rapidly crumbling away; many of these records are done with such poor ink that they are now barely legible. For these reasons it would seem to be wise economy to inaugurate, without further delay, a comprehensive scheme for carefully copying and comparing all of these records, to the end that the copies might be used in place of the originals, except in matters of the greatest importance.

Moreover some provision should be made for the better preservation of all these original documents from fire or theft. To these ends I recommend that an appropriation to cover the cost of a suitable modern safe and the services of draughtsmen and copyists of say $4,000, be included in this year's "supply bill."

GOOD ROADS.

The time can not be far distant when the matter of a radical improvement of our present system (?) of highways must receive the earnest attention of the Legislature, for it is certainly conceded that such an improvement is needed and demanded, and I think it safe to assume that the most intelligent opinion on the subject now is that State aid is essential to its accomplishment.

Considerable interest was manifested in this subject during the Legislature of 1896 and various measures were introduced, some asking for large appropriations for a prompt beginning of actual work, while the more moderate ones simply asked that a small appropriation be made available for proper and intelligent study of the varied aspects which the subject presents, preparatory for future legislation. While these measures differed on the general lines above noted, they also presented widely divergent views as to the organization required for the management and supervision of the actual work, or the preparatory study of the subject, and it is to these points that I now wish to direct your attention. On which ever of the above lines the initiatory steps in this matter may be taken, it is certain that the great bulk of the work, aside from actual construction, will be solely of an engineering nature. As this department already has an organization of trained engineers, selected from the competitive Civil Service lists, and extending into every county of the State, I believe and urge that it should be charged with the execution of any and all work in this line which you may decide to direct, especially since such a course would not entail any additional cost of supervision.

The demand for better roads is certainly a growing one and must soon be met with a satisfactory and tangible answer. That

the present methods of laying out, building and maintaining our public roads are ridiculously expensive and thoroughly unsatisfactory to all concerned, is certain, and is growing to be a matter of common notoriety. It is equally certain that the magnificent roads so common to the principal European countries, as well as to some of our States, and even to some sections of this State, can be conclusively proven to be better investments than the amounts annually squandered on our ordinary country roads, which, taken as an average, are a standing disgrace to our boasted civilization, and our general intelligence.

These conditions should be promptly improved, but they probably will not be until the proof is forthcoming from some source, that the outcome will surely leave a balance on the right side of the taxpayers ledger.

Aside from all other considerations and the knowledge of the beneficient influence already exerted on those localities which have shown sufficient enterprise to construct an intelligent system of highways, the proofs above mentioned, can be had, but their collection will take some time and cost some money, but this great State can afford the latter and should make use of the former before undertaking any comprehensive system or plan of improvement. Accordingly and to this end I recommend that an appropriation of $10,000 be made, to provide for the salary and necessary expenses of an additional assistant engineer, to be assigned especially to this work, to prepare such a report for the next Legislature as will form a guide and basis for further action.

SHINNECOCK AND PECONIC CANAL.

The work authorized by chapter 932 of the Laws of 1895, which appropriated $12,800, and chapter 348 of the Laws of 1896, which

appropriated $5,000, has been completed during the past season. This work consisted of completing the piling and protecting the banks of this canal and of building a set of stop gates to regulate the height of the Shinnecock bay, the level of which had fallen about two and one-half feet since the building of the canal. All the work in connection with the building of these gates had to be done with the water in the canal, as it was impossible to coffer dam and drain the work even if the appropriation had been sufficient to cover such work.

Many difficulties were encountered and successfully overcome, and the gates have already proven their effectiveness by raising the waters of Shinnecock bay to their original height, thus stopping the damage that was being wrought to many hundreds of thousands of dollars worth of fine property bordering its shores by the growth of vegetation and the stench from same as it decayed on being uncovered between the heights of the original flow line and the lower flow line which has ensued the building of the canal to connect Shinnecock with Peconic bay.

The tops of the gates are placed about eighteen inches above the normal height of Shinnecock bay, and as they open and close automatically with the tides, retaining part of the water from each flood tide, the surface of the bay is maintained at its proper stage. But one thing is now needed to complete this otherwise satisfactory job, and until it is done, the very life of the other work is seriously threatened.

The Long Island Railroad Company's bridge now spans the canal just north of the tide gates. The present canal has an average width of 100 feet, while the clear width between the abutments of this bridge is only 40 feet. The effect of a northeast gale is to pile the waters against the north side of the bridge and then

forcing it through the contracted channel between the bridge abutments, forms a whirlpool at this spot.

The difference in elevation of the water surface between the northern and southern sides of the bridge, for a distance of about 60 feet, is sometimes as great as five feet, and the water rushes through with astonishing velocity, carrying with it all the sand in its course. The use of these abutments has long since been abandoned by the railroad company, and the present bridge rests on bearing piles exclusively. Immediately after such a storm, 42 feet of water has been found at this spot, and within four days thereafter this has been reduced to 17 feet, showing the entensive movement of sand by the scouring of water at this point. Except in the vicinity of this bridge, the waters of the canal at all stages and at all times are calm and tranquil, doing no damage to the bottom of the canal or its banks.

Some means must be adopted soon for changing this bridge so as to leave the waterway under it of the same width as the balance of the canal, and it is hoped that the questions of liability and responsibility in connection with the bridge as between the State and the railroad company, which are now before the Board of Claims for adjudication, will be settled in time so that the present Legislature can adopt such means as may seem warranted under the circumstances for settling the present difficulty.

The inlet or connection between the Atlantic ocean and Shinnecock bay, opposite the canal, as directed by chapter 950 of the Laws of 1896, has been completed as far as originally intended, during the past season, and a channel 30 feet wide on the bottom and 6 feet deep, with slopes of 1½ to 1, has been excavated from the bay toward and as close to the ocean as experience dictated to be safe. Next spring at an opportune time, which always

occurs at that season, when the water in the bay is unusually high from the influx of surface and spring water and the tides in the ocean are very low producing a temporary difference in level often as great as six feet, the present barrier at the end of this channel will be broken through, thus permitting an enormous outflow from the bay to the ocean, completing the channel by its own action and leaving a connection between these waters, which is expected to have a salutary and beneficial effect on the fishing and oyster industries, the former of which though once of great importance, has been practically destroyed since the channel which formerly connected the shore and bay at this point was closed about eight years ago. The oyster industry is now alone of sufficient importance to warrant the expenditure of all sums thus far spent by the State in this locality.

GENESEE STORAGE SURVEYS.

The Supply Bill, chapter 950, Laws of 1896, appropriated the sum of $10,000 for further investigation of proposed dam on the Genesee river and for the best means of transportation of material to its site and for detailed plans.

Under the provisions of this clause of the Supply Bill further investigations have been made on the Genesee river with the result of indicating that a site at Portage is far preferable to the sites in the vicinity of Mount Morris as previously considered. The reasons for this conclusion may be found in detail in the accompanying report of George W. Rafter, the engineer-in-charge. Without going into detail we may give the following as the present state of the Genesee river storage problem. The reasons for the conclusions here announced may be found in Mr. Rafter's report:

(1) Of the several available sites for storage reservoirs on the

SHINNECOCK AND PECONIC CANAL—DRIVING PILES FOR GATE FOUNDATION.

SHINNECOCK AND PECONIC CANAL.
Showing Destruction of New Piling, Caused by Contraction of Channel.

SHINNECOCK AND PECONIC CANAL.
Looking toward Shinnecock Bay—Showing Partial Cutting of Inlet to Ocean.

SHINNECOCK AND PECONIC CANAL.
Looking toward Shinnecock Bay—Showing Highway Bridge and Protection of Banks.

SHINNECOCK AND PECONIC CANAL.
Gates Closed—Showing Greater Heighth of Water in Shinnecock Bay.

SHINNECOCK AND PECONIC CANAL.
Gates Open—Water Flowing into Shinnecock Bay.

SHINNECOCK AND PECONIC CANAL.
Showing Channel Contracted by Abutments of Long Island R.R. Bridge.

SHINNECOCK AND PECONIC CANAL.
Showing Method of Repairing New Piling at Railroad Bridge.

Genesee river complete surveys show that the Portage site is preferable to all others because of affording the greatest possible storage at the smallest cost per unit volume.

(2) As the result of three years gaugings of the Genesee river, as made by this department, it is determined that the minimum flow of the stream may be as low as about 6.67 inches on the watershed for an entire water year, this figure having been actually reached for the water year of 1895.

(3) As shown by data derived from the previous Genesee storage reports, the estimated cost of a storage reservoir at Mount Morris, with a capacity of about 7,370,000,000 cubic feet, is $2,785,000, giving a rate per million cubic feet stored of $377.88.

(4) Serious floods have occurred in the Genesee river at a number of times within the historical period. The flood of March, 1865, did at least $1,000,000 damage in the city of Rochester alone, some of which was chargeable to difficulty at the Erie canal aqueduct.

(5) The flood in April, 1896, was very nearly as severe as the flood of March, 1865, but by reason of more fortunate conditions comparatively little damage was done, although a study of the data at hand shows that the danger limit was very nearly reached.

(6) A study of existing conditions indicates the interesting fact that the Genesee river drainage area has been nearly denuded of forest. While this condition obtains, severe floods are likely to occur.

Without drawing final conclusions, it may be stated that deforestation of the drainage area is largely responsible, tending, as it does, to not only increase floods somewhat but leading directly to material decrease in the amount of water flowing in the stream from year to year.

Comparison of the conditions existing on the drainage area of

the upper Genesee river with those of the upper Hudson which is still largely in forest indicates apparently a much less runoff under given conditions from the Genesee than from the Hudson, thus verifying the preceding conclusion as to the effect of deforestation in decreasing the runoff.

(7) As regards the upper Genesee river the forest has been entirely removed by land owners who have profited commercially by such removal. The effect of their action has been nevertheless to permanently injure the riparian owners. Hence, it seems proper that the State should expend money either in reforesting the area or in constructing river regulation works. Of these two, the latter appears preferable because the benefits may be realized in a few years.

(8) The proposed Portage reservoir will impound 15,000,000,000 cubic feet of water at a total estimated cost of $2,600,000, or at a cost of $173.33 per million cubic feet stored.

(9) The proposed Portage reservoir, storing 15,000,000,000 cubic feet of water, is 500 feet higher than the proposed Mount Morris reservoir storing 7,340,000,000 cubic feet, and affords a permanent, continuous, total power over and above the low water power of the stream of 50,496 gross horse power; whereas the Mount Morris reservoir would afford only 11,000 gross horse power over and above the present low water power of the stream.

(10) Capitalizing the value of the permanent power produced by the construction of the Portage reservoir at 4 per cent., and we reach a total of $12,624,000; on the other hand, the capitalization of the total value of the permanent power produced by the proposed Mount Morris reservoir yields a total of $2,900,000; the difference in capitalization becomes, then, $9,724,000.

Incidentally the vast difference between the two sites here given

may serve to indicate the vast importance of studying these new projects thoroughly on their merits before actually deciding as to location.

(11) The estimated cost of a reservoir at Portage storing 7,340,-000,000 cubic feet is $1,800,000, or nearly $1,000,000 less than for a reservoir storing the same quantity at Mount Morris.

(12) The enlarged canal requires about 80 cubic feet of water per second for every month of the navigation season from May to November, inclusive, except in the month of May, when an average of 177 cubic feet per second is required. In order to provide for this amount of water as well as for some little contingency in the way of breaks during the navigation season there should be constructed immediately a storage on the Genesee river of about 2,500,000,000 cubic feet. A reservoir of this capacity is estimated to cost at Portage $1,350,000. Further, the estimated cost of a dam storing 2,500,000,000 cubic feet but with such breadth of base as to admit of extension to the full height required for the storage of 15,000,-000,000 cubic feet is $1,700,000.

(13) Based on manufacturers' rating as to capacity of turbine water wheels, the present total developed water power of the Genesee river, from Portage to Rochester, inclusive, is 19,178 horse power; or, basing the amount of power on the manufacturer's rating of water required, assuming 75 per cent. efficiency on the wheels, the total power is 17,248 net horse power, of which 16,683 net horse power is within the limits of the city of Rochester.

(14) The present extreme low water power of the Genesee river at Rochester is 5,046 net horse power, of which 2,523 net horse power will be rendered practically useless to its owners by reason of taking 80 cubic feet per second in every month except May, and 177 cubic feet per second in that month for the purposes of the

enlarged Erie canal. By way of showing this, it may be mentioned that had the enlarged canal been in operation in 1895 and 1896, and taking water at the stated rate, the amount actually taken from the Genesee river in the month of May, 1895, would have been 46 per cent. of the total flow of the stream for that month; in June, 28 per cent. would have been taken; in July, 34.5; in August, 31.5; September, 36.2; October, 34.8; November, 8 per cent. In May, 1896, the canal would have taken 51.3 per cent. of the total flow of the stream; in June, 12.2; July, 15.9; August, 19.2; September, 24.5; October, 2.0 and in November, 4.6 per cent. It is clear, then, that the necessary abstracting of this large quantity of the water of the river for the purposes of the canal is an exceedingly serious matter to the owners of the water power at Rochester.

(15) Taking the rental price of power in Rochester and we deduce an annual value for 2,523 net horse power of $126,150; capitalize this sum at 4 per cent. and it becomes $3,153,750. It is in view of such extended injury to the water power of the stream that the riparian owners now ask the State to construct the Portage reservoir substantially as proposed.

Considering the significance of these large figures as to the injury to the Genesee river water power following the taking of the quantity necessary for the purposes of the enlarged canal it must be borne in mind that Rochester is a city of 160,000 inhabitants depending almost entirely on its manufacturing industries. A very large proportion of those industries are based upon the rental of small lots of power, as, for instance, from one-half to 10 horse power. It is obvious that with the possibility before the owners of this power of being deprived at any moment of one-half their water it will work very serious injury, because of the impossibility of determining just when the motive power is to be shut off. By

way of enforcing this proposition it may be mentioned that in spite of the fact that the Genesee river has a total fall of 262 feet within the limits of the city of Rochester, nevertheless the manufacturers of that city use, according to recent statistics, fully 500,000 tons of soft coal for steam purposes per year.

UPPER HUDSON STORAGE.

Chapter 320, Laws of 1896, appropriated $10,000 for the purpose of continuing the survey of the upper Hudson valley as inaugurated by chapter 599 of the Laws of 1895. As in the previous year, arrangements were made with the United States Geological Survey for the prosecution of the topographical work under a joint agreement, the United States Geological Survey furnishing $5,000 as against $5,000 furnished by the State from this appropriation, thus making a total expenditure on the upper Hudson area of $15,000.

The investigation as to possible sites of dams, area, storage capacity, etc., of reservoir sites, was continued under the direction of Mr. Rafter as in 1895.

Sites for dams have been surveyed at Tumblehead Falls, Hadley, Tahawus, Boreas river, Boreas Point, Newcomb, and additional surveys at Indian lake. The detailed plans on a number of these dams are in course of preparation and may be found in connection with Mr. Rafter's report on the upper Hudson storage.

Perhaps as interesting a line of investigation as any in connection with the upper Hudson valley survey is that with reference to the influence of the forest on the runoff of streams. Under this head a large amount of information has been collected, which is given at length in the detailed report. Studies of this character are specially interesting, because of the immense practical importance of knowledge of the relation of the forest to stream flow.

Without attempting to decide the question at the present time the data collected indicates that in the State of New York with a given rainfall the total runoff of streams may be as much as six inches less from deforested areas than it is from those still in forest. The reasons for this conclusion are given in the detailed report.

Considerable data has also been gathered with a view of determining a runoff formula applying to the upper Hudson area. The practical advantage of such a formula is that we may take the existing rainfall and temperature records, so far as they are available, and determine for the last 40 or 50 years just what the approximate flow of the stream has been for each year, in this way obtaining a valuable guide as to what the minimum unregulated flow of a stream may be expected to be in years to come.

Investigations have also been continued as to the available storage of the upper Hudson valley, with the result of determining that probably a considerably larger area may be developed to substantially full capacity than indicated in the previous report.

The possibility of supplying Greater New York with water from the upper Hudson area has received some attention from this department, and is believed to be a matter of sufficient importance to merit attention by the Legislature. As shown in the upper Hudson report of last year a storage of at least 41,593,000,000 cubic feet can be easily obtained. The investigations of this year indicate that this quantity can be considerably added to. The present daily use of water in New York city varies from 150,000,000 to 200,000,000 gallons per day, or from 230 to 300 cubic feet per second. If we multiply these figures by four we obtain, as the maximum, 1,200 cubic feet per second. It is believed that this quantity could be easily furnished, if needed, without interfering with the inter-

ests of either the State canals or the manufacturing establishments on the stream. In any case if on further investigation it should appear that the upper Hudson valley would not furnish sufficient storage, the additional storage, whatever it may be, can be easily obtained from the head waters of the Mohawk river, on either the East or the West Canada creeks, or both. The State Engineer is of the opinion that the question of additional future water supply, not only for Greater New York, but for the numerous other cities and towns of the lower Hudson valley, is of sufficient importance to justify detailed surveys with reference to determining all the special questions in regard to public water supplies from the Adirondack region which have arisen. Inasmuch as the State canals must necessarily draw a considerable portion of their supplies from this region, and, further, by reason of the immense manufacturing interests which have been developed on the Hudson and Mohawk rivers, it is pointed out that any such investigation, in order to be effective, must necessarily be broad enough to take into consideration all the interests involved.

TOPOGRAPHIC SURVEY OF THE STATE.

Chapter 480 of the Laws of 1896 authorized the State Engineer and Surveyor to continue to co-operate with the director of the United States Geological Survey in making a topographic survey and map of the State of New York, and appropriated for this work the sum of $10,000.

Your attention is called in connection with this provision to that portion of this report relating to the "Topographic Survey of the Upper Hudson Valley," continued in accordance with chapter 320 of the Laws of 1896, which carried an appropriation of $10,000, and from which, with the consent of the Superintendent

of the Public Works, I allotted the sum of $5,000 for continuing the topographic survey of the Hudson river above Glens Falls.

In accordance with the provisions of the first of these laws, I entered into the following agreement with the Hon. Charles D. Walcott, Director of the United States Geological Survey, which is similar in all essential details to agreements made in former years between this office and the United States Geological Survey.

AGREEMENT BETWEEN THE STATE ENGINEER AND SURVEYOR OF NEW YORK AND THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY FOR THE CONTINUATION OF THE CO-OPERATIVE TOPOGRAPHIC SURVEY OF THE STATE OF NEW YORK, AS PROVIDED IN CHAPTER 480 OF THE GENERAL LAWS OF 1896.

1. The preparation of the map shall be placed under the supervision of the Director of the United States Geological Survey, who shall determine the methods of survey and map construction.

2. The order in which, in point of priority, different parts of the State shall be surveyed shall be agreed upon in detail by the State Engineer and the Director of the United States Geological Survey.

3. The work shall be based upon the triangulation of the United States Coast and Geodedic Survey, the United States Lake Survey and the New York State Survey, and wherever the triangulation is deficient it shall be supplemented by the United States Geological Survey.

4. The survey shall be executed in a manner sufficiently elaborate to prepare a map upon a scale of 1: 62,500, exhibiting the hydrography, hypsography and public culture, and including all town and county boundary lines as established and marked by the State Engineer and Surveyor at the time of its completion in form

similar to the sheets already completed in this State. The preliminary field maps shall be on such a scale as the Director of the United States Geological Survey may select to secure accuracy in the construction of the final map.

5. The hypsography shall be shown by contour lines with vertical intervals of 20 feet.

6. The heights of important points shall be determined and furnished to the State Engineer.

7. The outlines of wooded areas shall be represented upon proofs of the engraved map to be furnished the State Engineer.

8. For convenience the Geological Survey shall, during the progress of the field work, pay the salaries of the persons employed therein, while the traveling, subsistence and field expenses shall be paid for the same time by the State. For office work on map the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost to the State of New York of the field and office work for the current year shall not be more than ten thousand dollars ($10,000), and provided that the United States Geological Survey shall expend an equal amount.

9. During the progress of the work, free access to the field sheets and records of the topographers and draughtsmen shall be afforded the State Engineer and Surveyor and his assistants for examination and criticism; and should the said State Engineer and Surveyor of New York deem that the work is not being executed in a satisfactory manner, then the said State Engineer and Surveyor may, on formal notice, terminate this agreement.

10. The resulting map shall fully recognize the co-operation of the State of New York.

11. When the work is completed, the State Engineer and Sur-

veyor shall be furnished by the United States Geological Survey with photographic copies of manuscript sheets; and when the engraving is completed, and at all times thereafter when desired, the said State Engineer and Surveyor shall be furnished by the said Survey with copper plates of the sheets of the maps for use in transferring for printing editions of said maps.

(Signed) CHAS. D. WALCOTT,
Director United States
Geological Survey.

(Signed) CAMPBELL W. ADAMS,
State Engineer and Surveyor.

I append hereto the report of the Director of the United States Geological Survey which summarizes the results of the field season's operations under the above acts. I also append lists of permanent benchmarks established by spirit leveling, and descriptions and preliminary positions of primary triangulation stations located in the course of the prosecution of this work. This report and the accompanying lists of elevations and positions I commend to your thoughtful examination, as I am sure that you can not fail to appreciate, as I do, the skill and economy which have been displayed in carrying forward the work planned.

TRIANGULATION.

I desire especially to call your attention to two features of this work which have been introduced this year for the first time, and which, in my opinion, add materially to its usefulness and popularity. The first of these is the establishment of azimuth marks or true north and south lines at each county seat included within the area under trigonometric survey. The other is the extensive amount of careful spirit leveling prosecuted in the course of which

permanent benchmarks have been left at short intervals over the entire area under survey.

Each azimuth line is marked by two stone monuments placed from four hundred to six hundred feet apart, bearing in their centers copper bolts with the center marked. The direction between these two monuments is a true meridian line and by its aid local and county surveyors will be enabled to test their compass needles and determine their deviation and correct them accordingly.

The value and necessity of the primary triangulation work will be appreciated when I state that the positions of all points on the earth's surface mapped in the prosecution of the topographic survey are by this means exactly located by geodetic co-ordinates, consequently the direction and distance of any point shown on a topographic sheet can be absolutely referred to that of any other point on any other topographic sheet by simply scaling the same from the paper. Such a result is not possible by any other method of map-making, as the errors introduced in direction surveys, where distances are obtained by measurements with the tape and chain, soon become so great as to render their accurate mapping on a grand scale impossible of accomplishment. All of the work of topographic mapping is based on the few scattered positions determined by the trigonometric survey. In places such survey has already been prosecuted by the United States Coast and Geodetic Survey, by the United States Lake Survey and by the New York State Survey. Such prior work has in every case been utilized in making the present topographic survey, but it has been necessary in many places to supplement this by additional trigonometric work.

Early in June Mr. W. J. Peters was assigned the duty of extending primary triangulation from the coast survey line "Hamilton

Mountain—Prospect Mountain," in the neighborhoods respectively of Lake Pleasant, Hamilton county, and Caldwell, Warren county, northwestward to locate a sufficient number of triangulation points to furnish a basis for the extension of topographic work on the upper Hudson valley. As a result of this work he located 12 triangulation points on mountain summits on the North creek, Schroon lake, Newcomb, Thirteenth lake, Indian lake and Blue Mountain atlas sheets in Warren, Essex and Hamilton counties. This work, in addition to furnishing a base for the topographic mapping of the Newcomb, Thirteenth lake and Indian lake sheets during the past season, affords a basis for the future extension of such work over the Blue Mountain sheet.

Early in August, having completed the triangulation planned for the upper Hudson, Mr. Peters was directed to extend triangulation from the neighborhood of Elmira, N. Y., westward, to furnish trigonometric points as a basis for topographie mapping on the Corning, Addison, Rocksville, Wellville, Friendship and Olean sheets, in Steuben, Allegany and Cattaraugus counties. In the execution of this work he located exactly the positions of nine trigonometric stations on mountain summits, completing his field work toward the end of October. The extension of this primary triangulation permitted the topographic mapping of the Olean sheet and has furnished positions for future topographic work on five additional sheets between Elmira and Olean. The total result of the primary triangulation has been the establishment of azimuth lines marked by stone monuments at Lake Pleasant, Hamilton county, and at Belmont, Allegany county, and the trigonometric control of 12 atlas sheets covering 2,500 square miles. The total cost of this work, including salaries, was $2,870, or at the rate of $1.15 per square mile controlled by triangulation.

SPIRIT LEVELING.

During the past season much more careful attention than heretofore was paid to the spirit leveling necessary to furnish base elevations for the mapping of the contour lines, or the lines of equal elevation above sea level by which the topographic relief of the country is represented. The primary spirit levels were run by four leveling parties, two in the upper Hudson basin, and one with each of the main topographic parties operating in Central and Western New York. This primary leveling was conducted with such degree of accuracy that no check determination of any elevation gotten from two or more lines of levels was permitted to differ by an amount greater than that represented by the formula

$$.05\sqrt{\text{Distance in miles,}}$$

the result giving the admissible error in feet. By this formula, for instance, the error permissible in a line 100 miles in length is but five-tenths of one foot. It is worthy of note that, though the degree of accuracy called for is unusually high for engineering spirit levels, yet in every case the closure checks obtained were invariably well within the limit prescribed. The details of these checks are to be found in the lists of elevations appended hereto.

These levels were run in accordance with an act of Congress under which the Geological Survey conducts its topographic mapping, and which requires that "in every 36 square miles mapped there shall be determined by careful spirit leveling the elevation, above a central datum chosen for each area under survey, of a copper or bronze tablet which shall be left as a permanent mark." The fulfilment of this requirement calls for the location of benchmarks with such frequency that they shall not exceed in any direction six miles apart over the area surveyed. In addition to these copper

benchmarks there were left a great many other benchmarks, as a nail in the root of a tree, the cornerstone or doorstep of a masonry building, the masonry abutment of a bridge, etc., which are situated at distances of about one mile apart along the line of levels. These benchmarks will be of the greatest service to engineers and surveyors in the prosecution of all future engineering work, as they will furnish accurate datum points upon which to base levels for city or canal water supply, for the location of railway lines and for similar purposes. It will be of interest to engineers in general to know that the average rate of running these levels was 1.4 miles per working day over the roughest portions of the Adirondack region, and 3.4 miles per day over the more level portions of Central and Western New York, while the average cost per linear mile run in each locality was respectively $6.50 and $2.64.

The spirit leveling in the Adirondack region was primarily based on a copper tablet set in a vertical rock face 1,000 feet northwest of the railway station at North Creek, the elevation of which was accepted as 1,007.964 feet, gotten through railroad and State Engineer's levels run from Erie canal levels to the track at North Creek. At the close of the season a check line for the further reduction of these elevations to sea level was started at the United States Engineer Corps benchmark near Fonda and run via Johnstown and Gloversville to connect with the Adirondack levels at Wells, in Hamilton county. The final reduction of this work has not yet been made, as the field work is still in progress.

In the neighborhood of Utica the spirit levels are based on a bronze tablet set in the rear of the government building at Utica, the elevation of which is accepted as 418.816 feet as based on the United States Engineer Corps precise level line to Utica.

In the neighborhood of Auburn, Skaneateles and Moravia they

are based on a copper bolt in the State dam at Skaneateles, the elevation of which is accepted as 871.604 feet, as based on Erie Canal levels and the levels of the City Engineer of Syracuse.

For the neighborhood of Albion, Lockport and Medina, they are based on a bronze tablet set in the front wall of the county courthouse at Lockport, the elevation of which is accepted as 615.639 feet, as based on Erie Canal levels.

Near Olean they are based on a bronze tablet set in the foundation wall of the City building in Olean, the elevation of which is accepted as 1457.458 feet, as based on the elevation of the top of rail at the intersection of the Erie and the Western New York and Pennsylvania railroads, reduced through from sea level.

There were run in New York during the past season 1,025 miles of primary spirit levels, and there were left as monuments on the ground 120 copper bolts and bronze tablets cemented into rock; the copper bolts bear the legend, "U. S. G. S. —— feet," and the bronze tablets the legend, "U. S. Geological Survey, B. M. —— feet; $250 fine for disturbing this mark;" and they have stamped on them the elevation to the nearest foot. In addition the elevations were determined of 1,230 other bench marks, as the tops of rails at railroad station, a nail in the root of a tree, or the masonry doorsills or cornerstones of buildings, abutments of bridges, and other suitable places.

Besides the above primary levels, there were determined by spirit leveling of a less degree of accuracy, or by trigonometric methods, the elevation within three feet of 4,600 points, usually the summits of hills, the elevation of ground surface at road crossings or of bridges crossing streams; and in addition, by less accurate methods, chiefly by aneroid well checked, there were determined the elevations of 19,400 points, which were used in sketching in the field

details of the topographic map. In all, there were determined 25,200 elevations above sea level, over an area of 2,580 square miles mapped, or nine elevations per square inch of map surface.

TOPOGRAPHY.

In accordance with the plans arranged at the opening of the field season, four topographic parties were placed in the field early in June—two under Messrs. W. H. Lovell and W. M. Beaman, respectively, on the Thirteenth lake and Newcomb sheets in the upper Hudson drainage basin, and two much larger parties, under Messrs. J. H. Jennings and Frank Sutton, respectively, on the Skaneateles, Moravia, Auburn and Utica sheets in Central New York, and the Olean, Albion, Medina, Lockport, Olcott, Ridgeway and Oak Orchard sheets in Western New York.

The net result of the field work of these parties is shown in the following table:

COUNTY.	Atlas sheet.	Area square miles.	Remarks.
Essex, Hamilton	Newcomb	215 5	Sheet completed.
Warren, Hamilton	Thirteenth lake	216.4	Sheet completed.
Hamilton	Indian lake	70.0	Sheet not completed.
Oneida, Herkimer	Utica	218.2	Sheet completed.
Onondaga, Cayuga	Skaneateles	219.0	Sheet completed.
Cayuga	Auburn	219.0	Sheet completed.
Cayuga, Tompkins	Moravia	219.9	Sheet completed.
Orleans, Genesee	Medina	218.2	Sheet completed.
Niagara, Erie	Lockport	218.2	Sheet completed.
Orleans, Genesee	Albion	218.2	Sheet completed.
Niagara	Olcott	100.0	Partial sheet bordering Lake Ontario, completed.
Orleans	Ridgeway	110.0	Partial sheet bordering Lake Ontario, completed.
Orleans	Oak Orchard	106.0	Partial sheet bordering Lake Ontario, completed.
Cattaraugus, Allegany.	Olean	221.6	Sheet completed.
		2,570.2	

The Adirondack parties were working in the most rugged portions of that region, where travel is almost wholly by canoe or on

foot, through brush and woods and over precipitous mountains. In consequence the cost of this work was much higher than elsewhere, the total cost of field work for the season for these two parties being $8,000, or at the rate of $16 per square mile mapped. Including office expenses the cost of this work will be $20 per square mile. In the prosecution of this work Mr. Beaman, with two assistants and a level party, completed the Newcomb sheet, area 215 square miles, and Mr. Lovell, with two assistants and a level party, completed the mapping of the Thirteenth Lake sheet, area 216.4 square miles, and one-third of the Indian Lake sheet, 70 square miles; and these parties determined the positions trigonometrically of 5.6 points per square inch of map, traversed 2.4 miles of roads or lake shore line and streams per square mile, and determined the elevations by all methods of 2.6 points per square inch of map. There were now 265 miles of primary levels at a cost of $1,720, being at the rate of $6.50 per linear mile or of $3.44 per square mile mapped.

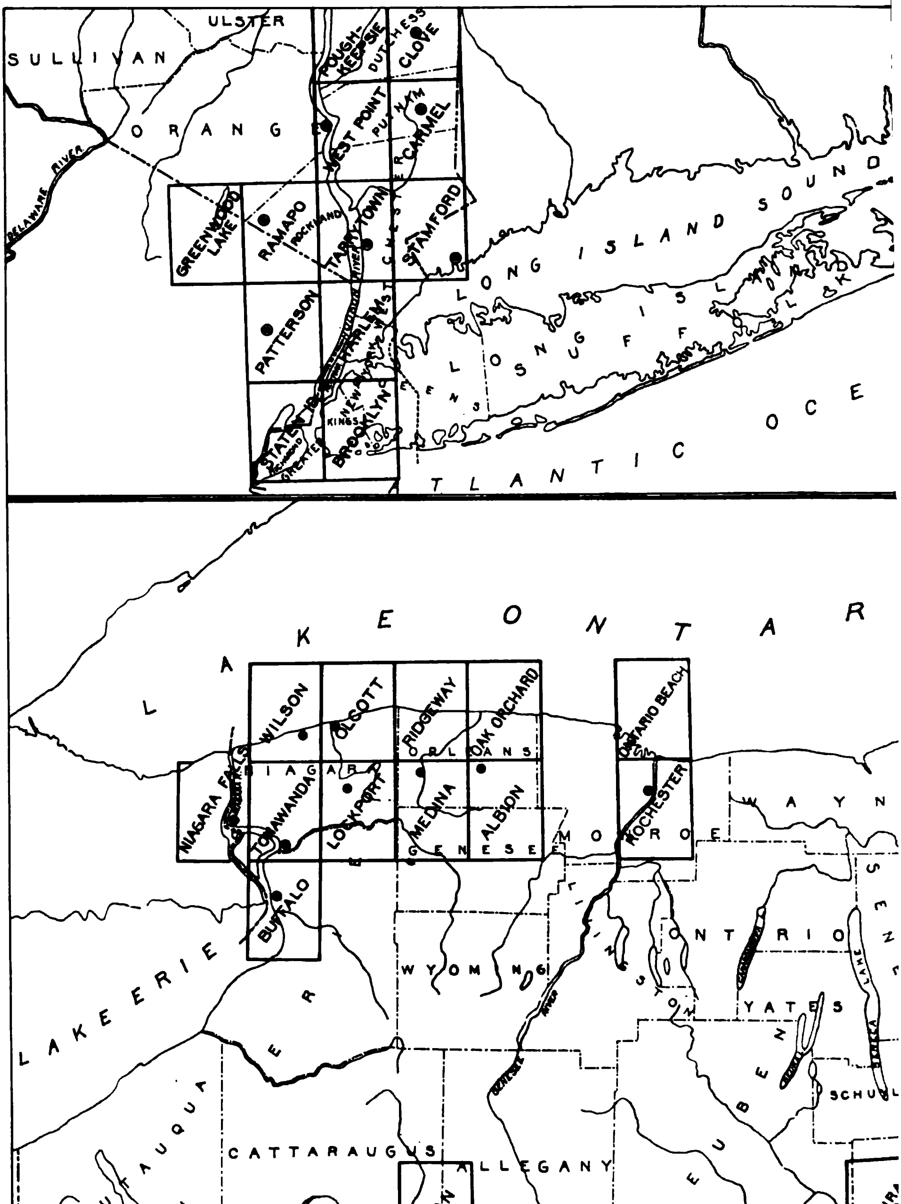
The party working in Central New York under the general direction of Mr. J. H. Jennings, who was assisted by Messrs. C. C. Bassett and A. M. Walker, mapped 875 square miles, completing the Utica, Skaneateles, Moravia and Auburn sheets, at a total cost of $5,655, or at the rate of $6.45 per square mile for field work, and including estimated office expenses of $8.38. In the prosecution of this work they determined by trigonometric methods the positions of 2,020 points, an average of 2.3 per square inch of map surface; established 330 benchmarks and 2,220 other level elevations, and including aneroid elevations a total of 10,900 elevations, or at the rate of 12.45 elevations per square inch of map surface; and traversed 2,230 miles of roads, an average of 2.5 per square mile. There were run 212 miles of primary spirit

levels at a total cost of $805, being at the rate of $3.80 per linear mile, or 92 cents per square mile controlled.

In Western New York another large party, under the general direction of Mr. Frank Sutton, with Messrs. E. B. Clark, R. D. Cummin, and J. H. Wheat as assistants at various times, completed the mapping of the Olean, Lockport, Medina, Albion, Olcott, Ridgeway and Oak Orchard sheets, a total area of 1,203 square miles, at a total cost for field work of $7,000 or at the rate of $5.82 per square mile and, including estimated office expenses, of $7.50 per square mile. In the prosecution of this work they established by trigonometric methods the positions of 810 points, established 1,170 benchmarks, determined the elevation by level of 340 other points, and in all, including aneroid elevations, determined the heights of 4,200 points, being at the rate of 4.7 elevations per square inch mapped; and in addition they ran 2,880 miles of traverse, or 1.9 miles per square mile. There were run 490 miles of primary levels at a total cost of $975, being at the rate of $1.95 per linear mile and of 81 cents per square mile controlled.

It is again a pleasure to call your attention to the accuracy with which the estimates, both of cost and time, for the prosecution of this work, have been carried out. In the Adirondack region a little more difficult country was encountered than was anticipated, and there the area mapped was a little below and the cost a little above the estimates, but this difference was more than made up by the additional work and the decreased cost of the topographic work in other portions of the State.

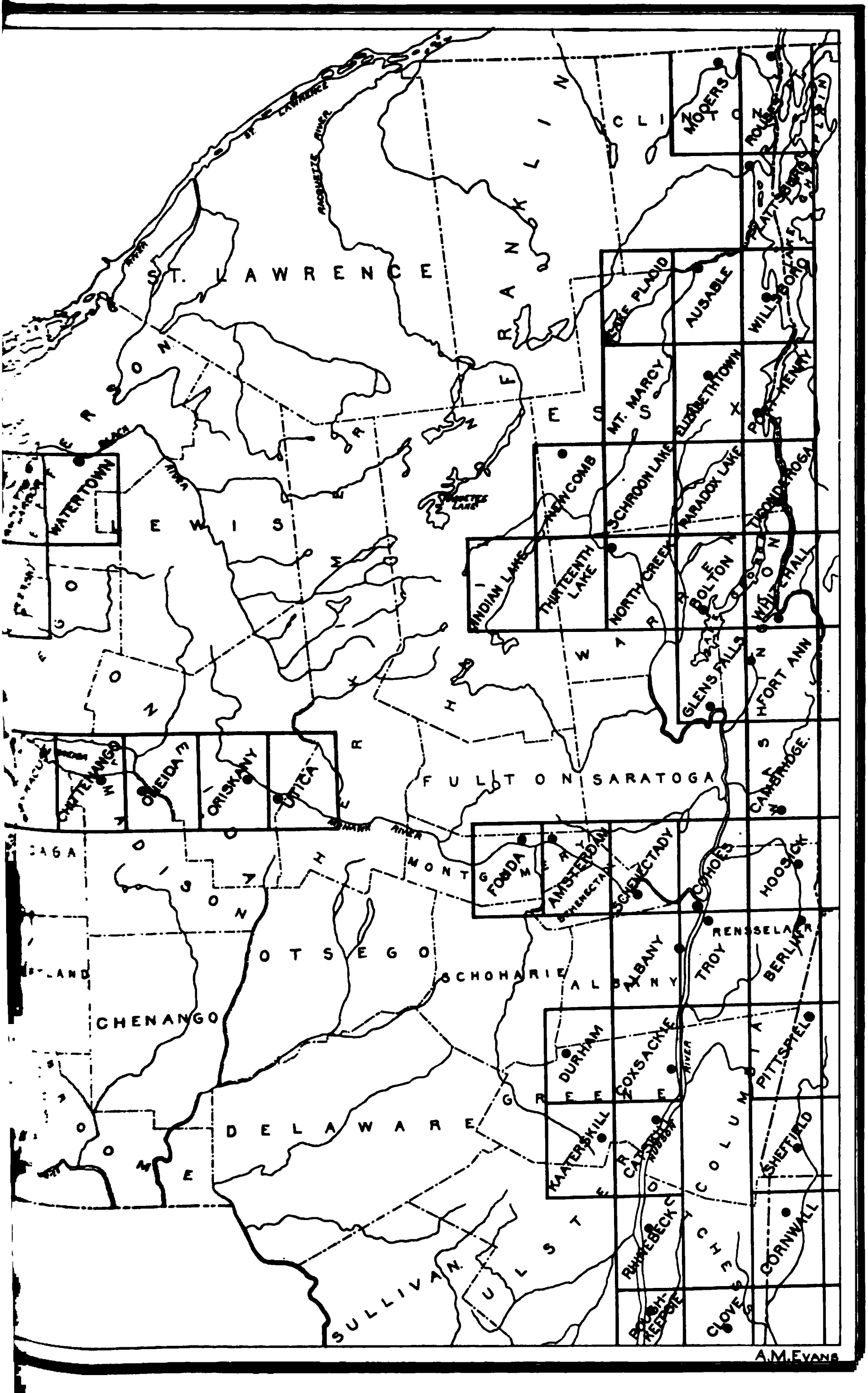
Prior to the last field season, that of 1896, there were mapped by the United States Geological Survey in co-operation with this office, 10,120 square miles of the area of the State. There were



PROGRESS MAP OF NEW YORK

SHOWING ATLAS SHEETS SURVEYED
BY THE
U.S. GEOLOGICAL SURVEY IN CO-OPERATION WITH THE STATE ENGINEER
CAMPBELL W. ADAMS.
STATE ENGINEER AND SURVEYOR

PROGRESS TO DEC. 31, 1896.



ST. LAWRENCE
ST. LAWRENCE RIVER
RAQUETTE RIVER
FRANKLIN
CLINTON
MOOERS
ROUSES
PLATTSBURG
LAKE PLACID
AUSABLE
WILLSBORO
MT. MARCY
ELIZABETHTOWN
PORT HENRY
ESSEX
NEWCOMB
SCHROON LAKE
PARADOX LAKE
TICONDEROGA
INDIAN LAKE
THIRTEENTH LAKE
NORTH CREEK
BOLTON
WHITEHALL
LAKE GEORGE
WARREN
WASHINGTON
GLENS FALLS
FORT ANN
WATERTOWN
LEWIS
HERKIMER
HAMILTON
ONEIDA
CHITTENANGO
ONEIDA
ORISKANY
UTICA
MOHAWK RIVER
FULTON
SARATOGA
CAMBRIDGE
FONDA
AMSTERDAM
SCHENECTADY
COHOES
HOOSICK
MONTGOMERY
MADISON
OTSEGO
SCHOHARIE
ALBANY
RENSSELAER
TROY
BERLIN
CHENANGO
DURHAM
COXSACKIE
GREENE
PITTSFIELD
COLUMBIA
DELAWARE
KAATERSKILL
CATSKILL
HUDSON RIVER
SHEFFIELD
BROOME
ULSTER
RHINEBECK
DUTCHESS
CORNWALL
SULLIVAN
POUGHKEEPSIE
CLOVE
A.M.EVANS

mapped during the past season 2,570 square miles, making to date a total area mapped of nearly 12,700. The total cost of this map work done in previous years was $105,300, and the cost for the past year, including estimated office expenses, was $30,000, making the total cost to date of $135,000, which is at the rate of $10.32 per square mile, or but a little over the estimate of the director of the Geological Survey, which was that the cost for the whole State would average $10 per square mile. As the remainder of the State is easier to map and will cost less, it is almost certain that by the time the total area has been mapped the cost will be below $10 per square mile.

There yet remain about 36,000 square miles of the State to be mapped, and I earnestly hope that you will appreciate the wisdom and economy of continuing this co-operation on such liberal lines as will permit the completion of this work within a reasonable length of time. An appropriation of $25,000 or $30,000 per annum continued for the next seven years would witness the completion of this work. I therefore earnestly recommend that such an appropriation be made for the continuance of the joint co-operative topographic survey, under the direction as heretofore of the State Engineer and Surveyor and the Director of the United States Geological Survey, and to this effect suggest that provisions similar to that of chapter 480 of the Laws of 1896, carrying an appropriation of $30,000, be inserted as an item of the supply bill for 1897.

TOPOGRAPHIC SURVEY OF THE UPPER HUDSON RIVER VALLEY.

Chapter 320 of the Laws of 1896 provides in part that "The State Engineer and Surveyor and the State Superintendent of Public Works shall continue the survey of the upper Hudson valley au-

thorized by chapter 599 of the Laws of 1895, etc." For carrying out the above purpose, the sum of $10,000 was appropriated, of which, with the consent of the Superintendent of Public Works, I allotted the sum of $5,000 for continuing the topographic survey of the Hudson river basin above Glens Falls.

In accordance with the provisions of this law, and in order to carry out the plans arranged for the topographic mapping, the following agreement, similar to that arranged last year, was made between the State officials and the Director of the United States Geological Survey:

AGREEMENT BETWEEN THE STATE ENGINEER AND SURVEYOR, THE SUPERINTENDENT OF PUBLIC WORKS OF THE STATE OF NEW YORK AND THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY FOR THE SURVEY OF THE UPPER HUDSON RIVER VALLEY, AS PROVIDED IN CHAPTER 320 OF THE GENERAL LAWS OF 1896.

1. The preparation of the map shall be placed under the supervision of the Director of the United States Geological Survey, who shall determine the method of survey and the map of construction.

2. The survey shall be executed in a manner sufficiently elaborate to prepare a map upon a scale of 1:62,500, exhibiting the hydrography, hypsography and public culture, and including all town and county boundary lines as established and marked by the State Engineer at the time of its completion in a form similar to the atlas sheets of the United States Geological Survey already completed in the State. The preliminary field maps shall be on such a scale as the Director of the United States Geological Survey may select as to secure accuracy in the construction of the final map.

3. The hypsography shall be shown by contour lines with vertical intervals of twenty feet.

4. The heights of important points shall be determined and furnished to the State Engineer.

5. The Geological Survey shall pay the salaries of the persons employed therein, while the traveling, subsistence and field expenses shall be paid by the State in such a way as to equalize all expenses, provided that the total cost to the State of New York of the field and office work shall not be more than $5,000 and provided that the United States Geological Survey shall expend an equal amount.

6. During the progress of the work, free access to the field sheets and records of the topographers and draughtsmen shall be afforded the State Engineer and his assistants for examination and criticism, and should the State Engineer of New York deem that the work is not being executed in a satisfactory manner, then the State Engineer may, on formal notice, terminate this agreement.

7. When the work is completed, the State Engineer shall be furnished by the United States Geological Survey with photographic copies of the manuscript maps.

(Signed) CHAS. D. WALCOTT,
Director United States Geological Survey.

(Signed) CAMPBELL W. ADAMS,
State Engineer and Surveyor.

(Signed) GEO. W. ALDRIDGE,
Superintendent of Public Works.

The net result of the work performed by the topographers of the U. S. Geological Survey is reported upon elsewhere under the title of "Topographic Survey of the State." It will be noted that the topographers completed the mapping of 500 square miles, besides which triangulation was extended over this area and 700

square miles additional of the upper Hudson drainage basin, which is yet unmapped. Previous to the field season of 1896 there were mapped 837 square miles of the upper Hudson basin, making the total area of that basin mapped to date 1,337 square miles, and leaving yet unmapped 1,463 square miles. If I am able to make a further appropriation during the fiscal year of 1897 of $10,000 for the continuation of this work, to be met by a like amount allotted by the Director of the U. S. Geological Survey, I feel confident that this will see the final completion of the topographic mapping of the upper Hudson drainage basin.

The State may well congratulate itself on the success already obtained in the prosecution of this work. The region under survey is one of the most difficult and inaccessible in any portion of the United States. It is exceedingly rugged and mountainous, densely covered with a heavy growth of timber and underbrush, and transportation and the prosecution of the various surveying operations is much impeded by the lack of roads or even paths. The parties making these surveys have been compelled to wade through streams, travel through the woods and brush on foot in the slowest and most laborious manner, carrying heavy packs of instruments, provisions and blankets, or to navigate the various streams and lakes and carry from one to the other their boats and camping and surveying outfits.

In addition to the topographic mapping above described, the topographers made careful surveys of all lakes, ponds or swampy areas which afford possible sites for storage reservoirs for the further supply of water for the Hudson river. The results of these examinations have enabled them to furnish a preliminary statement of the location, area, approximate capacity and dimensions of five possible reservoir sites, having a total capacity of

...000,000 cubic feet, while from the general topographic map of the country the areas of catchment basins which supply these reservoirs with water can be readily measured. It will thus be seen that the topographic survey of this region has furnished, as I stated last year, a more complete, expeditious and economic survey of the water resources of this region than could have been obtained by any other method.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C., *December* 4, 1896.

Hon. C. W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Sir.— I have the honor to make herewith a statement of the work done under agreements signed last July by the Superintendent of Public Works and the State Engineer and Surveyor of New York and the Director of the U. S. Geological Survey. By the terms of these agreements $15,000 was allotted by you for expenditure in making co-operative topographic surveys therein arranged for. Of this sum, $11,846 were expended during the field season which has just closed. The remainder, $3,154, I request your authority to devote to the payment of salaries connected with the office mapping of these surveys in order that the State may expend a total sum equal to that devoted to the same purpose by this organization under the terms of our agreements. In the prosecution of this work this survey has expended during the past season $12,761 on field work, and the permanent office salaries connected with the mapping thereof are estimated to cost $5,430, thus making a total expenditure of $30,037, a portion of which will, presumably, be defrayed, as above suggested, by the State in payment of salaries.

The result of this work has been the prosecution of an accurate trigonometric survey over 2,500 square miles of the State in which surveys were not heretofore existent. There were left on the ground in the course of this work 21 stone monuments bearing in their centers copper bolts on which are stamped the legend "U. S. G. S.—N. Y.," and the centers of these bolts mark the positions on the ground which have been determined by geodetic methods. There were also left two stone monuments, bearing copper bolts in their centers, at Newton Corners, county seat of Hamilton county, and at Belmont, county seat of Allegany county, which monuments locate true meridians, and the direction between them is accordingly a north and south line.

In the course of the topographic survey there were run 1,025 miles of very careful spirit levels, and there were left on the ground 120 copper bolts and bronze tablets as permanent benchmarks, bearing on their faces their elevations to the nearest foot, and there was established 1,230 other benchmarks of less permanence, as a nail in the root of a tree, or some portion of a masonry building or bridge, and in similar suitable places.

The total result of the topographic surveys prosecuted under the agreements was the accurate mapping on the scale of 1:62,500 and with a contour interval of 20 feet of 2,570 square miles. The total cost for field work was $24,607, or at the rate of $9.57 per square mile, and the cost, including estimated office expenses, was $11.12 per square mile. There were surveyed in previous years by this State 10,120 square miles of the area of the State, making the total area mapped to date 12,690 square miles, and as the total expenditure has been $135,000, the cost of mapping has been at the rate of $10.32 per square mile.

Of the areas above enumerated, 502 square miles was included within the Hudson drainage basin, and was mapped under one of the agreements, the cost for this work being far above that for the remainder of the topographic work in the State, namely, $10,990, including the expenditure on account of primary triangulation. There remain yet unsurveyed in the Hudson drainage basin 646 square miles, and elsewhere in the State, approximately, 35,350 square miles, and I estimate that the average cost of mapping this work will not exceed $10 per square mile, though the large amount of additional primary triangulation which it will be necessary to prosecute hereafter because of its absence in the areas yet unmapped, may add to this at the rate of $1.15 per square mile for an approximate area of 20,000 square miles.

Immediately upon the signing of the agreement under which this work was prosecuted, arrangements were made for the placing of the various topographic parties in the field, and by June 1st Messrs. J. H. Jennings, C. C. Bassett and A. M. Walker were at work on the Central New York area, Messrs. Frank Sutton, E. B. Clark and J. H. Wheat (who was later relieved by Mr. R. D. Cummin) were at work on the Western New York area, and Messrs. W. M. Beaman and W. H. Lovell were at work on the upper Hudson survey; while Mr. W. J. Peters was engaged in prosecuting primary triangulation over a portion of these areas. Field work for all of the parties was closed early in December, and photographs of the field sheets, reduced to the scale of 1:62,500, will be forwarded you as rapidly as they can be prepared.

Yours with respect,

CHAS. D. WALCOTT,

Director.

ELEVATIONS BY SPIRIT LEVELING.

The spirit leveling done in New York during the past season in connection with the topographic surveys was of an unusually high degree of accuracy. This was because of a recent act of Congress under which the topographers of the United States Geological Survey were working, which required that they: "Should establish in each area under survey, and mark upon the ground by iron or stone posts or permanent benchmarks, at least one such mark in each 36 square miles or equivalent area."

In consequence of the above, the work was done under instructions which required that any elevation gotten from two or more lines of levels should not be permitted to differ by an amount greater than that represented by the formula the result giving the

$$.05\sqrt{\text{Dist in miles.}}$$

admissible error in feet.

The permanent benchmarks left in accordance with the above consist of three standard forms: A copper bolt four inches in length and one inch in diameter on top, set in a hole drilled in rock or masonry, its top level with the surface and stamped with appropriate letters, and the approximate elevation to the nearest foot; of bronze tablets three and one-half inches in diameter and let into vertical walls, the horizontal cross mark in the center of the tablet indicating the elevation of the benchmark and the tablet being appropriately lettered, the approximate elevation being stamped thereon; and finally, where rock and masonry can not be found, of an iron post three and one-half inches in diameter and four feet long set in the ground with one foot of its length projecting, capped by a riveted bronze tablet marked as in the previous case.

The approximate elevation stamped upon these benchmarks is

dependent upon the nearest obtainable elevation above mean sea level as based on a central datum point chosen for each area under survey. The object of this is that the figures of elevation so stamped approximately to the nearest foot, shall replace a consecutive numbering for the benchmarks, these figures, in addition to being those above sea level, are also the numbers by which the benchmarks will hereafter be designated. Necessarily as the central datum point is ultimately connected with sea level by precise levels, its published elevation will be changed from time to time and with it correspondingly the elevation determined for each benchmark. The intention is that these corrections shall be published from time to time, both in the reports of the State Engineer and Surveyor and those of the Director of the United States Geological Survey.

It has already occurred in the case of the levels in the Adirondacks, which were temporarily based on an elevation at North Creek, gotten from railway levels, that the figures stamped upon the benchmarks in that region differ about four feet from their best-known elevation above sea level, because, since the completion of that survey, a careful line of levels has been run from the Adirondacks, connecting with the precise levels of the United States Engineers near Fonda.

The elevations hereinafter published are in every instance reduced to the latest information regarding the height above mean sea level, of the central datum point on which they rest. Accordingly, these published elevations differ in every case from the figures stamped on the post or marks, yet it is believed that these latter will be of great value for the general uses of engineers, surveyors and others, for the reason that they accord among themselves though not absolutely reduced to sea level, an impossible operation,

and for the further reason that they will be reduced from time to time, as nearly as possible to sea level in corrected publications.

These lists give the height of the permanent copper and bronze benchmarks to the thousandth of a foot, and give other elevations to the tenth and hundredth of a foot respectively, according to the permanence and character of the temporary benchmark to which they refer. They depend upon four central datum points, one for the leveling in the neighborhoods of Utica, Fonda and the upper Hudson valley and the Adirondacks; one for the neighborhood of Auburn and Skaneateles; one for the neighborhood of Medina, Lockport and Albion; and one for the Olean region.

Since these levels were run in the field during the past summer, and the benchmarks were stamped, there has been gotten by reduction of two precise level lines run by the United States Coast and Geodetic Survey, one from Boston and one from New York, a new determination of the gristmill benchmark at Greenbush, near Albany. This is the ultimate primary sea level datum of the United States Coast and Geodetic Survey and upon it depends the precise level line of the United States Engineer Corps up the Mohawk valley to Oswego. The latest determination of this benchmark lowers it 1.085 feet, and this amount has therefore been subtracted from all the elevations determined during the season.

The Fonda benchmarks, being those on the line via Gloversville to Speculator, were stamped in accordance with the United States Engineer Corps precise level benchmarks as a datum, and have been therefore reduced by 1.085 feet. The Adirondack benchmarks were based on an approximate elevation at North Creek, derived from the Adirondack Railway. The Fonda connection with these elevations, changed them by 4.032 feet, which amount was subtracted from them in addition to 1.085 feet. The Utica benchmarks

were stamped in accordance with the State canal benchmarks as a datum, and have therefore been increased by the difference between minus .085 and plus 1.185, which latter is the difference between the State canal datum and the United States Engineers precise level line; a total correction of plus 0.1 feet. The Auburn elevations have been corrected by minus 1.085 and plus 0.641, the latter figure being the difference between the United States Engineers precise level line; a total correction of plus 0.1 feet. The Auburn elevations have been corrected by minus 1.085 and plus 0.641, the latter figures being the difference between the United States Engineers precise level line and the State canal elevations on which leveling was based for this neighborhood, a total correction of minus .444 to the field elevations. The Lockport levels have been corrected in the same way and by the same amount as the Auburn levels. The Olean levels are based on an assumed elevation gotten from the top of rail in front of station of the Western New York and Pennsylvania railroad tracks in Olean, an approximate datum.

FONDA, GLOVERSVILLE, FAYVILLE, SPECULATOR, INDIAN LAKE, THIRTEENTH LAKE, NORTH CREEK, NEWCOMB AND BLUE MOUNTAIN LAKE SHEETS.

The elevations in the following list are based on a bronze tablet in the foundation stones of the county court-house at Fonda, which is marked "U. S. Geological Survey. Elevation 294 feet. B. M." The elevation of this benchmark above mean sea level is gotten from the nearest permanent benchmark of the United States Engineer Corps' precise level line. As reduced in accordance with the latest information, the height of this is 293.129 feet. The leveling was done by Messrs. Clark Brown and A. F. Krause, levelmen, and W. S. Walcott and J. G. Mislin, rodmen, under the general direction of Messrs. W. H. Lovell and W. M. Beaman, topographers.

AURIESVILLE TO GILMAN LAKE, VIA FONDA, GLOVERSVILLE AND NORTHVILLE.

Schoharie Creek aqueduct, Erie canal; cross on corner-stone of northwest abutment of first bridge west of (United States Engineering Corps, B. M.)..........	301.770
Auriesville, West Shore railroad station; bridge over canal three-eights mile west of; square chiseled in corner-stone, northwest end of west wing, north abutment	302.31
Auriesville, West Shore railroad station; bridge over canal one-half mile west of; cross cut in stone in fourth course north abutment, one and one-half feet east of east angle of abutment..........................	301.84
River road crossing, south abutment of bridge over canal at; square chisel mark on northeast corner of east stone of third course..........................	299.94
Fultonville, bridge over Mohawk river, one-half mile east of; top of stone monument on north side of river road.	288.08
Fultonville, bridge over Mohawk river; square chisel mark on top coping of south abutment............	293.53
Fonda, county courthouse; cross on bronze tablet set in corner-stone of fourth course of stones from top of foundation at northwest corner marked "294 feet"..	293.129
Cayadutta creek, Fonda, Johnstown and Gloversville railroad bridge over; square chisel mark in northeast corner of coping stone, southeast end of south abutment	350.08
Fonda, two miles north of; cross cut in face of stone in north wall of F., J. & G. R. R. culvert No. 2........	464.15

Sammonsville, F., J. & G. R. R. station; cross cut in large stone at south corner of foundation................	586.54
Sammonsville railroad station, one and three-eighth miles north of on F., J. & G. R. R.; cross cut in stone in face of southwest wall of culvert................	649.51
Johnstown, F., J. & G. R. R. crossing at Montgomery street, 60 paces northeast of; cross cut in stone west corner of foundation of frame house on southeast side of street	648.55
Johnstown, F., J. & G. R. R. station; cross on bronze tablet set in first stone below brickwork, at west corner of building, marked "652 feet"...............	651.238
Johnstown, one and three-eighths miles north of on F., J. & G. R. R.; square chisel mark in southeast corner of top stone of west wall of culvert No. 2............	722.13
Johnstown, two and one-eighth miles north of on F., J. & G. R. R. bridge No. 5; square chisel mark on northeast corner of top stone east end of abutment.......	748.81
Gloversville, square cut in southwest corner of stone in north abutment of bridge No. 6, F., J. & G. R. R., 100 paces from Main street	768.28
Gloversville, F., J. & G. R. R. station; cross in bronze tablet set in first stone below brickwork 20 feet north of southwest corner of building marked "798 Ft."..	797.280
Gloversville, southeast corner of Bleecker street near cast-iron post, bridge over Cayadutta creek; square chisel mark in top of stone, south abutment........	808.70
Gloversville, Kingsboro avenue, five-eighths of a mile west of Kingsboro avenue station; square chisel mark on stone in east wall of culvert	850.17

Gloversville, Kingsboro avenue; frame house on west side of, 100 feet north of railroad crossing; cross cut in stone near southeast corner of foundation......	873.86
Gloversville, two miles north of Kingsboro avenue station on F., J. & G. R. R.; square cut in stone in west wall of cattle pass	812.78
Broadalbin Junction, top of frog in switch at..........	812.12
Broadalbin Junction, road crossing 500 feet northeast of.	814.58
Anthony's crossing, center of road at................	792.18
Mayfield, one mile south of; northwest corner of west coping of arch culvert, square chisel mark..........	772.06
Mayfield, platform at railroad station................	762.00
Mayfield, iron highway bridge, floor of..............	762.69
Mayfield, road crossing by grist-mill................	759.89
Mayfield, water surface mill-pond, Mayfield creek......	754.09
Mayfield, 60 feet east of grist-mill, 30 feet from creek and 90 feet south of railroad track; copper bolt in boulder five feet broad, marked "U. S. G. S., 756 Ft."	751.159
Van Nostrands, 2,000 feet southwest of railroad station opposite northeast end of curve; square chisel mark on outcrop 15 feet west of track....................	743.96
Van Nostrands, road crossing at railroad station.....	741.79
Cranberry creek, two and one-quarter miles south of railroad station; square chisel mark on boulder 300 feet west of railroad track, halfway to barn	740.13
Cranberry creek, Main street; 300 feet north of railroad crossing and 100 feet west of railroad track, copper bolt in boulder 3 feet high, marked "U. S. G. S., 768 Ft."	762.533

Sweet's crossing, 200 feet north of and 20 feet west of railroad track; square chisel mark on boulder 8 feet broad	825.89
Sacandaga park schoolhouse, one-half mile east of, 30 feet north of open culvert, 20 feet east of railroad; square chisel mark on boulder	804.31
Sacandaga park schoolhouse, ground elevation at base of	804.8
Sacandaga park, one-half mile south of; road crossing	810.9
Sacandaga park, 125 feet south of road crossing at; boulder 60 feet west of main line railroad, square chisel mark	813.03
Sacandaga park, road crossing.....................	807.4
Northville, Sacandaga river, floor of bridge over......	761.79
Northville, Sacandaga river, bridge over; copper bolt in top step, north wing of west abutment, marked "U. S. G. S., 765 Ft."...........................	759.876
Northville railroad station, platform of..............	763.69
Northville, one mile above; square chisel mark on boulder 4 feet west of road at south edge of clearing on west side of river	758.17
Van Vranken's (white) house, base of...............	769.0
West Stony creek, first house (white) south of iron bridge over; base of	785.9
Northville, 3 miles north of, 50 feet north of West Stony creek iron bridge on west side of river; square chisel mark on boulder 10 feet west of road.............	786.43
Willard cemetery, base of yellow house opposite, west side of river	789.9
Falls brook, floor of bridge over....................	796.7

Sacandaga river, 40 feet from on west bank; rock on south bank of brook, 20 feet west of road and 200 feet south of clearing, square chisel mark..............	782.28
Twenty-mile post, 150 feet north of; rock 20 feet east of road, marked "B. M. o 11.8".....................	793.32
Mitchell's hotel, south step of piazza; stone marked "B. M. o 123" with chisel	806.27
Mitchell's white house, base of	806.3
Hope district schoolhouse No. 4, base of..............	831.8
Hope district schoolhouse No. 4, 75 feet west of; boulder 15 feet north of road, copper bolt marked "U. S. G. S., 832 Ft."...........................	827.021
Fifteen-mile post, 200 feet north of; boulder 15 feet west of road, marked "B. M. o 134"..................	890.00
Hotel, painted white, at southeast corner of road to east; base of	900.3
Fourteen-mile post, 150 feet northeast of; boulder at foot of hill, marked "B. M. o 139".....................	909.41
West river (west branch of Sacandaga river), opposite mouth of; 300 feet south of thirteen-mile post, boulder 50 feet east of river bank; square chisel mark......	909.09
Wells' tannery, one and one-eighth miles south of; boulder 15 feet east of road and 100 feet south of house, marked "B. M. o 143".....................	953.86
Wells, 500 feet north of tannery, in flat; boulder 20 feet east of road and 75 feet south of large barn, marked "B. M. o 147".................................	1,011.80
Wells, base of white church fronting west.............	1,009.0
Wells, base of yellow church with square topped tower, fronting east..................................	1,012.19

Wells, Hosley House; bronze tablet on rock 15 feet broad and 5 feet high in backyard of hotel, marked "1,026 ft."	1,029.940
Wells, east end of abutment of covered bridge, marked "B. M. o B. X."	987.40
Patent Line Monument in yard of white house opposite road to east; stone set in ground 15 feet southeast of house marked thus △ ; triangle is 6 inches on each side.	1,016.78
Elbow Bridge, stone 10 feet south of, and 4 feet west of road, marked "B. M. o C. C."	1,348.00
Hamilton lake, angle of road to; boulder 6 feet high and 15 feet broad, 40 feet from each road, west of junction, marked "B. M. A." with chiseled circle	1,692.04
Charley lake, schoolhouse opposite; copper bolt in boulder 8 feet broad, 25 feet southwest of school; bolt is marked "U. S. G. S. 1,719 Ft."	1,713.485
Charley lake, water surface	1,692.17
Charley lake, boulder 25 feet southwest of schoolhouse opposite, marked "B. M. C. G." with chiseled circle.	1,713.34
Gilman Lake outlet, 400 feet south of bridge over boulder 10 feet broad, 3 feet high, 40 feet east of road, marked with chiseled circle over legend "B. M. C. H."	1,669.75
Gilman lake outlet, floor of bridge over	1,650.89
Gilman lake, white house opposite center of; stone 100 feet south of building, 10 feet east of road, at trail to Griffin. This stone is marked with chiseled circle and legend "B. M. C. K." and is located 15 feet north of a stone marked in a similar manner with legend "B. M. C. J."	1,729.11

Indian Lake Atlas Sheet—Hamilton County.

SPECULATOR TO JESSUP'S RIVER.

Speculator, small triangular park at crossroads; copper bolt, set in boulder (P. 40 B. 1), marked "U. S. G. S. 1,772 Ft. B. M."	1,767.200
Speculator, ¾ mile northwest of; square chisel mark on outcrop in forks of road, 6 feet from left hand road, 20 feet from right hand road and 40 feet from fork	1,917.59
Echo lake, fork of road to; chiseled cross on stone	1,931.24
Speculator, 1 mile north of; road surface at summit	2,039.9
Speculator, 1¼ miles north of; chisel mark on boulder 5 feet east of road, opposite road south	1,948.06
Sacandaga Station Fish Hatchery, 125 feet south of; square chisel mark on boulder 15 feet east of road, 8 feet broad and 3 feet high	1,828.17
Sacandaga Station Fish Hatchery, ground at base of building	1,822.8
Sacandaga Station Fish Hatchery, floor of north bridge at	1,820.49
Sacandaga Station Fish Hatchery, 1 mile north of; square chisel mark on outcrop at height of land 400 feet south of 3-mile mark and 6 feet to left of road	2,015.01
Speculator, 3¼ miles from at head of path to Whittaker Lake House; chiseled cross on boulder	1,996.26
Sacandaga Station Fish Hatchery, 2½ miles north of; square chisel mark on boulder 2 feet high and 6 feet broad, 4 feet east of road, 100 feet north of 2-acre clearing	1,913.08
Jessup's river bridge, summit south of	2,013.6

Jessup's river bridge, floor of small bridge ⅛ mile south of	1,672.1
Jessup's river bridge	1,679.09
Jessup's river bridge, 50 feet west of on north bank of river; copper bolt in outcrop 5 feet above center of bridge, marked "U. S. G. S. 1,669 Ft. B. M."	1,683.843

JESSUP'S RIVER TO LEWEY RIVER.

Camp Perkins, piazza floor	1,697.39
Camp Perkins, one-fourth mile from at forks of Lewey lake and Cedar lake roads; nail in balsam stump 35 feet east of guide board and 12 feet north of road	1,718.03
Camp Perkins, one and three-fourths miles north of and at south edge of valley 600 feet wide; birch stump 2 feet in diameter 10 feet west of road, marked "EL. 1,756.335 Ft."	1,751.24
Mason lake stream, floor of bridge over	1,712.69
Camp Perkins, two and one-half miles from and 300 feet southwest of Mason lake boat landing; square chisel mark on boulder 5 feet west of corduroy road running parallel to Mason lake outlet	1,799.99
Mason lake, water surface	1,793.29
Mason lake, head of; boulder opposite, 120 feet northeast of birch tree 3 feet in diameter; tree is 3 feet east and boulder 10 feet west of road; square chisel mark	1,811.66
Mason lake, one and one-half miles north of head of; square chisel on wedge shaped stone 4 feet broad in road, due west of notch in high ridge three-fourths mile distant, to the east	1,723.5

Lewey Lake House (McCormick), piazza floor.........	1,661.89
Lewey lake, 100 feet from low-water line on south shore of, and 300 feet north of Lewey Lake House; copper bolt in boulder 8 feet broad, marked "U. S. G. S. 1,659 Ft. B. M."..............................	1,653.795
Lewey lake, elevation of water surface with dam open..	1,650.44
Lewey Lake House (McCormick's), one and one-half miles north of; square chisel mark on boulder 2 feet to right of road, 25 feet north of corduroy, 175 feet long......	1,660.94
Lewey river bridge, 50 feet north of, at head of Indian lake flow; square chisel mark on outcrop 5 feet west of road..................................	1,637.01
Lewey river, water surface at head of Indian lake flow..	1,626.05

LEWEY RIVER TO INDIAN LAKE.

Willow Creek bridge, 75 feet west of; square chisel mark on boulder 5 feet north of and 3 feet above road......	1,642.00
Willow Creek bridge, floor of	1,632.49
Farrington's, 400 feet southwest of road to; square chisel mark on boulder 2 feet high, 4 feet broad, 12 feet west of road..................................	1,823.88
Griffin Shanty brook, 300 feet northeast of; square chisel mark on outcrop east of road at top of hill..........	1,766.35
Beaver Meadow Brook bridge, 900 feet southwest of outcrop 3 feet above and 20 feet north of road, marked (1,799 feet) copper bolt, "U. S. G. S., B. M."........	1,793.943
Beaver Meadow brook, floor of bridge over...........	1,790.49
Griffin's large white house, elevation of ground at base of..	1,795.4
Beaver Meadow brook, one and one-fourth miles northeast of; elevation ground surface at base of........	1,689.6

Beaver Meadow brook, one and one-fourth miles northeast of; boulder 6 feet broad and 3 feet high, 50 feet north of road in barnyard, square chisel mark......	1,682.59
Washburn's (F.) white house, base of................	1,724.8

LEWEY RIVER TO INDIAN LAKE.

McCormick's Hotel (three story) 100 feet south of; square chisel mark on boulder 6 feet broad, 5 feet above and 20 feet north of road....................	1,758.18
Indian lake, west side of; base of schoolhouse........	1,687.9
Squaw brook, floor of bridge over..................	1,668.79
Lock's three story house; floor of piazza.............	1,712.69
Sabael postoffice; boulder 8 feet broad and 1 foot high, 6 feet south of path from Lock's house to boat landing, two-thirds of distance to and 50 feet above lake; marked with chiseled circle and letters "B. M."....	1,663.46
Sabael postoffice, one mile north of; square chisel mark on small boulder opposite log house, 10 feet west of road, 20 feet east of well, 150 feet south of small stream running into Indian lake..................	1,715.59
Christian Hill, south of; floor of sluice bridge........	1,691.59

LEWEY RIVER TO THAYER'S CAMP.

Old log camp, 300 feet west of; birch tree 2 feet in diameter, 5 feet south of road, marked "El. 1,759.552"..	1,754.44
Lewey river bridge, two and five-eighths miles from; beech tree, 12 inches in diameter, 10 feet north of road and 50 feet east of road to southwest.............	2,251.88
Thayer's lumber camp (house), 50 feet northeast of; birch tree, 15 inches in diameter, marked "2,492.251"	2,487.13

Thayer's shanty, on lot No. 42 west of Lewey lake; boulder midway between house and barn, marked with square chisel mark and figures "El. 2,488.88 Ft." cut in the stone	2,483.76

KINGS FLOW DAM TO ROSS (KUNJAMUCK).

Kings Flow dam, 500 feet northwest of bridge at; boulder 10 feet to right of and 1 foot above road; copper bolt marked "U. S. G. S., 1,724 Ft. B. M."	1,718.847
Round pond clearing, 15 feet south of; square chisel mark on rock 4 feet west of and 2 feet above road	1,886.95
Round pond clearing, one and one-half miles south of, 60 feet north from small brook; square chisel mark on boulder 6 feet west of and 2 feet above road	1,915.93
Round pond, 3 miles south of, at half-acre clearing; outcrop in brook, square chisel mark on point 4 feet up stream from small bridge	1,906.73
Ross, 2 miles north of; beech tree 16 inches in diameter in angle of road to southeast leading to Kunjamuck pond, marked "El. 1,950.662"	1,945.54
Ross, three-quarters of a mile north of, at road to upper Kunjamuck dam; basswood tree 2 feet in diameter in northeast angle of road, marked "El. 1,901.239"	1,900.15
Rock Pond stream, floor of bridge over, marked "El. 1,762.5"	1,757.39

ROSS TO SPECULATOR.

Ross' Kunjamuck House, 500 feet southwest from and 20 feet west of road; pine tree 1 foot in diameter marked "El. 1,783.085"	1,777.97

Ross' Kunjamack House, 2,000 feet south of; copper bolt in boulder 4 feet by 6 feet by 2 feet, 8 feet east of road, marked "U. S. G. S., B. M., 1,774 Ft."	1,769.206
Ciscoe brook, 100 feet south of; square chisel mark on boulder 1 foot above and 4 feet west of road........	1,768.14
Silver brook, 10 feet south of; square chisel mark on boulder 8 feet west of road........................	1,834.67
Mile Level, north end of; maple tree 14 inches in diameter 20 feet west of road, 125 feet north of small stream, marked "B. M., El. 1,768.102".............	1,762.98
Rylander clearing, west of Elm lake; copper bolt, in flat outcrop 6 feet west of road, 300 feet south of house foundation and 1,000 feet north of top of hill in road; bolt marked "U. S. G. S., B. M., 1,952 Ft".........	1,946.823
Log house, 300 feet south of in clearing opposite gravel pit; square chisel mark on boulder 20 feet east of road and 4 feet from forked cherry tree.............	1,907.52
Speculator, 1 mile north of; square chisel mark on boulder 3 feet above and 5 feet west of road, opposite small house 200 south of north end of clearing on west side of road..............................	1,787.17

SPECULATOR TO GILMAN LAKE.

Lake Pleasant outlet; floor of bridge over............	1,732.01
Speculator, 1 mile south of; boulder 6 feet west of 1 mile post and 5 feet south of road, 150 feet west of path leading south to spring; square chisel mark....	1,739.70
Speculator, one and one-quarter miles southeast of; outcrop on height of land, 20 feet north of road, marked with chiseled circle and letters "B. M. C. R."........	1,808.22

Speculator, 2 miles southeast of; square chisel mark on boulder 2 feet east of 2 mile post, 5 feet south of road, 125 feet west of sluice..........................	1,758.78
Speculator, 3 and one-eighth miles east of; outcrop on summit and 3 feet north of road, marked with chiseled circle and letters "B. M. C. R"..................	1,854.95
Gilman lake, floor of bridge over inlet...............	1,683.2
Gilman lake, near head of; 200 feet north of hotel; square chisel mark on boulder 3 feet above and 5 feet east of road................................	1,688.16
Gilman lake, hotel, floor of piazza..................	1,699.8

TRAIL, GILMAN LAKE TO GRIFFIN.

Gilman lake outlet, 40 feet from north bank of; balsam tree 12 inches in diameter 500 feet from head of Dunning pond, 20 feet from north bank of small stream; marked "B. M., El. 1,582.034"....................	1,576.92
Dunning pond, one-half mile east of; square chisel mark on boulder 15 feet west of forks of road, and 5 feet south of road................................	1,664.38
Auger Vlae, north side of; square chisel mark on boulder in center of road 10 feet from side of vlae and 5 feet from leaning maple 20 inches in diameter.......	1,630.62
Griffin, 2 miles north of; square chisel mark on boulder 5 feet east of road on left bank of Lake Pleasant stream, opposite Auger Flat dam..................	1,367.95
Griffin, N. Y., West House; piazza floor.............	1,339.39
Griffin, Sacandaga river bridge at; floor of, marked "El. 1,275"................................	1,270.01

Griffin; copper bolt in rock 5 feet north of road, 5 feet south of river and 30 feet above mill dam, marked "U. S. G. S., B. M., 1,280 Ft."	1,274.779

NORTH CREEK TO NORTH RIVER.

North creek, 100 feet north of railroad station; bronze tablet in quartz outcrop on southwest side of track, 2 feet above track and about 6 feet from southwest rail.	1,006.879
North creek, 1,000 feet north of railroad station; point in chiseled square on flat surface of quartz outcrop, 3 feet above tracks and 6 feet southwest of southwest rail	1,007.97
North creek, wild apple tree opposite white farm house one-quarter mile north of railroad station; tree is 40 feet south of road to house, is blazed, and the point of elevation is a nail driven in notch in root	1,003.72
North Creek railroad station; 1 mile north of at height of land in road, near blazed telegraph pole opposite gate and 400 feet east of house with single chimney; point in center of square chisel mark on small rock 45 feet south of road 6 feet behind larger and higher rock	1,038.27
Large rock 10 feet west of last described benchmark and 25 feet from fence, square chisel mark	1,041.38
Lone elm tree, 60 feet high, 300 feet north of house, 20 feet above river and 200 feet back from river, blazed; top of spike in notch cut on root	1,014.15
North Creek railroad station, 2 miles from; square chisel mark on large flat rock 6 feet broad, 15 feet west of road behind blazed elm tree	1,024.19

North creek, two and one-half miles from, opposite large white house with sun parlor in front; B. M. on highest rock in vicinity, 20 feet from main road and 50 feet from fence.................................. 1,029.82

North river, one and one-half miles south of; square chisel mark on large boulder inside of fence on west side of road in front of loghouse.................. 1,052.41

North river, 1 mile south of; square chisel mark on broad sloping outcrop at top of 4-foot fall in road; the mark is 15 feet west of road, 25 feet east of edge of outcrop, 2 feet from end of 5-inch step in rock and 3 feet west of intersection of two well-defined seams........... 1,046.86

North river, 1 mile south of and 50 feet from old road; square chisel mark on pyramid shaped rock 1 foot to right of wagon track............................ 1,049.12

North river, one-quarter mile south of; wire nail driven in top of oak stump connected to standing oak tree 8 inches in diameter at corner of garden in front of house... 1,051.94

North river, Thirteenth creek bridge at; extreme southeastern corner of southeastern wall plate (corner of plate bent upwards)............................ 1,073.19

North river, copper bolt in boulder 40 feet west of northwest corner of Thirteenth creek bridge, 30 feet east of corner of house; bolt is marked "U. S. G. S., B. M., 1,076 Ft."...................................... 1,071.088

North river, 300 feet west of bridge at; top of copper bolt under tripod signal of Adirondack survey—triangulation signal No. 118, 1882. (This signal is said to mark Warren-Essex county line)........................ 1,079.76

North Creek to Sodom.

North Creek, Adirondack hotel; top of fire hydrant at corner of barn 1,028.24

Bakers Mill pond, southwest edge of casting under southwest corner of bridge over North creek 1,815.69

North Creek railroad station, three-quarters of a mile south of; square chisel mark on quartz outcrop 15 feet to left of and 4 feet above road, 300 feet north of yellow house and 50 feet southeast from a similar outcrop 1,027.28

Road to southwest, 150 feet south of; square chisel mark on rock 4 feet high and 8 feet broad on the left of road 1,036.34

North Creek railroad station, 2 miles from; 300 feet east of yellow barn, on left of road, on bank of creek; square chisel mark on boulder 10 feet long, 7 feet broad and 2 feet high 1,054.80

North creek, two and one-half miles from, 300 feet south of schoolhouse; square chisel mark on outcrop 60 feet west of large barn, 10 feet left of road, 2 feet above road, 30 feet from junction of garden and road fences 1,094.02

North Creek railroad station, 3 miles from; and 100 feet from last described bridge; point in chisel mark 1 foot from south edge of large sloping boulder and 5 feet from ground measuring along slope 1,102.70

Outcrop, 150 feet north of place where road is built on cribbing circular chisel mark and letters "B. M. E." 2 feet from fence 1,126.64

Boulder, 4 feet to left of, and 2 feet above road opposite road to west; marked with circular chisel mark and letters "B. M. M."	1,167.12
Sawmill, 100 feet beyond and 20 feet beyond sluice bridge; square chisel mark on boulder 5 feet left of road.	1,192.87
House (red, small), 200 feet south of; boulder 20 feet to right of road, marked with chiseled circle and letters "B. M. G."	1,226.70
Sodom, three-eighths of a mile from; boulder on right of road 60 feet from road fence and 20 feet south of stone wall, marked with circular chiseled mark and letters "B. M. I."	1,350.68
Sodom postoffice, 10 feet from and 10 feet to left of road; flat circular rock, level with road, marked with circular chisel mark and letters "B. M. J."	1,443.47

SODOM TO BAKER'S MILLS

Ross' Mill, 6 feet left of road to, 60 feet from main road; square chisel mark on boulder, 2 feet above main road,	1,498.33
Ross' Mill, 500 feet beyond road to and 15 feet north of large pine tree 30 inches in diameter; large boulder on right of road, marked with circular chisel mark and letters "B. M. O."	1,530.18
Sodom and Baker's Mills, on road between; 500 feet from height of land, 8 feet from small sluice bridge; boulder 10 feet broad, 6 feet high, marked with circircular chisel mark and letters "B. M. P."	1,571.43

Sodom and Baker's Mill, road between; south of road to house, 200 feet to the right of main road; boulder 6 feet broad and 2 feet high, marked with chiseled circle and letters "B. M. Q."	1,568.66

BAKER'S MILLS TO MOUNTAIN HOUSE.

Baker's Mills, 50 feet north of blacksmith shop and 25 feet to right of road; boulder 6 feet broad and 1 foot below surface of road, marked with chiseled circle and letters "B. M. S."	1,579.94
Baker's Mills, 50 feet north of blacksmith shop and 25 feet west of road; copper bolt in boulder 6 feet broad and 2 feet above ground, marked "U. S. G. S., B. M. 1,585 Ft."	1,579.873
Baker's Mills, boulder at forks of road to west, marked with chiseled circle and letters "B. M. U."	1,587.24
Baker's Mills, Foley's hotel; opposite and on south side of road to west and west of north and south road; square chisel mark on flat boulder level with surface of road.	1,590.86
Boulder on right of road at junction of road to north, marked with chiseled circle and letters "B. M. X."	1,639.88
No. 11 Creek bridge, top of hill one-fourth mile west of; square chisel mark on boulder 5 feet to left of road.	1,725.45
Barn, small, 40 feet southeast of and 50 feet west of bridge; boulder 10 feet to right and 1 foot above road, marked with chiseled circle and letters "B. M. Y."	1,711.77

House (white) 100 feet southwest from and one-eighth mile east of height of ground; boulder 15 feet long and 6 feet high, 20 feet left of road, marked with chiseled circle and letters "B. M. Z."	1,818.63
Summit 50 feet east of west end of small meadow; 25 feet east of a boulder 10 feet broad and 4 feet high; boulder 25 feet left of road, marked "B. M. A. A." with chiseled circle	1,907.22
Thirteenth lake, one-fourth mile east of fork of road to; boulder 6 feet to left of road opposite log house, square chisel mark	1,830.35
Thirteenth lake, at fork of road to; boulder 8 feet above left-hand road 50 feet west of point of junction of roads, marked with circle and letters "B. M. A. D.," with chisel and white paint	1,784.43

MOUNTAIN HOUSE TO THIRTEENTH LAKE.

Diamond Mountain brook, 15 feet west of west bridge over; nail in notch on root of large three-pronged elm tree (blaze above nail is marked "B. M., El. 1,607.60")	1,602.49
Curtis clearing, opposite road to; spike in knot of wild cherry tree 15 feet to right of road (blazed below, marked "B. M., El. 1,635..804")	1,630.69
Outcrop near center of old clearing, 15 rods southeast from log shanty, 250 feet east from brook, 200 feet east from cellar of burned house; square chisel mark 3 feet to the left of road	1,638.69

Siamese ponds, junction of road to with road from Mountain House to Thirteenth lake; 20 feet east of junction and 15 feet left of road; notch on root of large elm tree, blazed and marked " B. M., El. 1,649.899 "..	1,644.7
Big Shanty dam, 200 feet southeast from east end of; copper bolt, set in boulder 3 feet high and 8 feet broad, marked " U. S. G. S., B. M. 1,666 Ft.".............	1,661.21
Big Shanty dam, one-half mile beyond; square chisel mark on boulder 8 feet west of and level with road in northern edge of upper clearing 100 feet south of edge of woods......................................	1,673.88
Big Shanty dam, one mile north of, and one-half mile north of upper clearing; north of bridge with 20-foot span, big birch tree on left of road, notched, blazed and marked " B. M. El. 1,703.375."...............	1,698.2
Thirteenth Lake House, one and one-half miles from; on, left of road in angle of wood road to southwest, 25 feet south of wood road running east to river and 50 feet south of small brook, balsam 10 inches in diameter marked " B. M. El. 1,759.853."...................	1,754.7
Thirteenth Lake House; 75 feet in front of; copper bolt, set in low flat outcrop, marked " U. S. G. S., 1,874 feet B. M."...................................	1,868.592
Thirteenth lake, at foot of trail from east side of Maxam's barn, on shore of lake, 50 feet from water's edge, 3 feet to right of straight trail and 4 feet above trail, large boulder, marked " U. S. G. S.," and chiseled square...................................	1,694.29

Warren and Hamilton Counties.

THIRTEENTH LAKE TO KINGS FLOW DAM.

Hour Pond brook, square chisel mark on outcrop at north end of lower bridge across	1,729.23
Hour Pond brook, 100 feet east of upper bridge over; square chisel mark on outcrop in road	1,896.02
Puffer pond, foot of; square chisel mark on broad flat rock in road, 100 feet north of point in road which is opposite outlet of pond, and 40 feet from the outlet	2,189.95
Puffer Pond road, junction of, with road from Kings to Humphrey clearing; maple 2 feet in diameter in southeast corner of roads, blazed and marked "B. M. El. 1,834.132"	1,829.01
Puffer and Kunjamuck roads, junction of; 500 feet northwest from; square chisel mark on boulder 5 feet to right of and 2 feet above road	1,718.83
Kings Flow dam, 500 feet northwest of bridge at; copper bolt in boulder 10 feet to right of and 1 foot above road, marked "U. S. G. S., 1,724 feet B. M."	1,718.847

Hamilton County.

KINGS FLOW DAM TO COPPER BOLT, SOUTH OF INDIAN LAKE VILLAGE.

Spring, 40 feet east of, on outcrop 100 feet north of house and 5 feet left of road	1,834 12
Forks of road, 30 feet west of; square chisel mark on boulder 4 feet broad, 5 feet to right of road	1,683.01
Bridge, 50 feet north from, on boulder 4 feet high, 8 feet broad and 6 feet to right of road; square chisel mark.	1,674.44

Schoolhouse, opposite; square chisel mark on outcrop 10 feet south of road and 20 feet west of bridge..... 1,628.57

Beaver Meadow brook, iron bridge over; top of rivet 2 inches from northwest corner of northwest wall plate. 1,605.19

Indian River bridge, 25 feet east of; square chisel mark on boulder 8 feet broad, 3 feet high, 20 feet north of road 1,597.74

Hamilton and Warren Counties.

GRIFFIN TO MOUNTAIN HOUSE.

Griffin Flow dam, 150 feet southeast of; boulder 5 feet north of road marked with chiseled circle, letters "B. M. B. B." and "El. 1,303 Ft."..................... 1,300.55

Griffin Flow dam, 1 mile east of and one-quarter mile east of isolated barn; boulder 2 feet south of and above road, 5 feet west of conspicuous boulder, mark; a chiseled circle and letters "B. M. B. A."............ 1,286.29

Griffin, 2 miles from toward Oregon; boulder 500 feet south of log house, opposite point of woods, 15 feet east of and 4 feet above road, marked with chiseled circle and letters "B. M. A. Y."................... 1,299.94

Griffin, three and one-half miles northeast of; 50 degrees west of height of land; boulder 10 feet broad and 3 feet high 15 feet west of road, marked with chiseled circle and letters "B. M. A. V.".................. 1,352.23

Hamilton-Warren county line, 1 mile northeast of; boulder in road 50 feet southwest of small brook, marked with a square chisel mark and "El. 1,365.... 1,360.38

Narrows, 300 feet north of summit at; boulder on right of road, marked with chiseled circle and letters "B. M. A. Q."............................ .. 1,367.35

Oregon, 2 miles southwest of and 75 feet south of Stuart's Creek bridge; highest point on unmarked boulder 20 feet east of road........................	1,366.66
Stuart's creek, 300 feet northeast of; point 5 feet west of road on outcrop, copper belt, marked "U. S. G. S., B. M. 1377 Ft."................................	1,371.97
Oregon, one-half mile southwest of; boulder 500 feet north of Johnson's Creek bridge and 5 feet west of road, marked with chiseled circle and letters "B M. A. N."	1,383.31

Warren County.

Oregon, 300 feet south of dam; point on outcrop 10 feet west of road, marked with chiseled circle and letters "B. M. A. L."................................	1,411.23
Oregon, 1,000 feet north of the North House (McKlosky's) and 150 feet north of curve to right in road; boulder 5 feet broad, 10 feet to right of road, copper bolt market U. S. G. S., B. M., 1,435 Ft "..........	1,429.836
Mountain House, clearing 1 mile south of; boulder 40 feet west of road, 200 feet south of log barn and 400 feet east of small pond marked with square chisel mark	1,586.28

NORTH CREEK TO MINERVA.

North creek, Hudson River bridge, upstream end of north abutment, marked with chiseled circle.......	1,005.31
North creek, 1 mile northeast of bridge over Hudson river and seven-eighths of a mile south of junction of road leading to east; square chisel mark on boulder 11 feet to left of and 1.5 feet above center of road....	1,166.85

North creek, two and one-half miles north of bridge over Hudson river and 1,100 feet south of junction of road leading to west; boulder 30 feet to right of and 5.8 feet above center of road, 150 feet west of north of new house on hill. Mark, a chiseled square............	1,087.07
Minerva, three and one-third miles southeast of, near county line; boulder 30 feet to left of and 1.4 feet above center of road, marked with chiseled circle and "U 2"	1,276.98
Minerva, 3 miles southeast of at junction of road leading to Olmstedville; square chisel mark on pointed boulder 9 feet to left of and 2 feet above center of road..	1,218.72
Minerva, 1 mile southeast of and three-eighths of a mile south of crossroads; square chisel mark on boulder 6 feet to right of and 1.2 feet above center of road..	1,341.33

Warren and Essex Counties.

NORTH RIVER TO INDIAN RIVER, VIA SUMMIT.

North river, doorsill of first house up the river from, on left side of road..................................	1,088.3
North river, three-quarters of a mile from; square chisel mark on pyramid-shaped rock on right of road at foot of big hill, 10 feet south of maple tree 10 inches in diameter and 200 feet north of house...........	1,086.96
One-mile post; square chisel mark on boulder by......	1,175.72
North river, one and one-half miles from, on level stretch of mountain road; square chisel mark on highest point of prominent boulder 6 feet to left of and 5 feet above road, 50 feet northwest of small swamp...........	1,324.28

North river, one and three-quarters miles from; point in circle on rock 15 feet to left of and 5 feet above road by spring; marked by chisel and paint with a circle and figures "117"	1,354.53
Two-mile post, 100 feet beyond; square chisel mark on highest corner of sloping rock 3 feet broad, 15 feet to left of road opposite small sluice bridge............	1,560.40
Barbers' mill, opposite road to; square chisel mark on rock 30 feet to left of road..........................	1,654.34
Barber pond, floor of sluice bridge at west end of.......	1,652.69
Three-mile post, floor of sluice bridge at..............	1,708.69
North river, three and one-eighth miles from; square chisel mark on prominent boulder in clearing on right and 60 feet from road, 150 feet south of log house....	1,728.69
North river, three and three quarters miles from; square chisel mark 10 feet beyond the highest point of low outcrop 8 feet to right of and 2 feet above road, 25 feet east of creek and 100 feet east of wood road at top of slight rise in flat..........................	1,751.17
Raquette brook, floor of bridge over.................	1,749.49
North river, four and one-quarter miles above on short flat at Casey's; square chisel mark on large boulder 6 feet broad, 3 feet high, 40 feet to left of and 1 foot below road, 8 feet east of barn..................	1,882.15
North river, four and three-quarters miles from, square chisel mark on flat outcrop 15 feet to left of and level with road at summit............................	1,983.05
Five-mile post, 20 feet west of; square chisel mark 10 feet to left of and 2 feet above road on outcrop......	1,908.95

North river, five and one-half miles from; square chisel mark on rock 5 feet to right of center of road, 1 foot above road, 40 feet west of height of road and 300 feet beyond clearing	1,913.88
Six-mile post, 400 feet beyond; square chisel mark on large boulder 7 feet broad, 25 feet to left of road.....	1,839.51
North river, six and one-third miles from, on flat 700 feet west of log barn; square chisel mark on boulder 10 feet broad, 6 feet to right of and 3 feet above center of road,	1,788.74
Seven-mile post, 500 feet beyond; square chisel mark on rock 6 feet broad and 10 feet to right of road at height of land	1,803.37
Tucker's (Fred.) house, northeast corner of; 40 feet northeast of; square chisel mark on rock 10 feet to left of road................................	1,814.44
Eight-mile post, 300 feet west of; point in highest part of square chisel mark on rock 8 feet left of road and 4 feet above road; 4 feet east of this rock is another rock one and one-half feet higher; across road is a boulder 18 feet long, 10 feet broad and 12 feet high..	1,755.20
North river, eight and one-half miles at east foot of Stepstone hill; rock 4 feet high 2 feet above road marked with a chiseled circle and "B. M. 108"............	1,747.74
North river, nine and one-eighth miles from; square chisel mark on projection at base of outcrop on north side, 40 feet to left of road, 50 feet from well, 75 feet beyond house................................	1,887.48
Flat, 500 feet west of house, 15 feet beyond farm road, rock 10 feet right of and 2 feet above road, marked with chiseled circle, also on back of rock "B. M. 107."	1,863.10

Spring's white house, copper bolt southeast of; in outcrop in front of log house, 10 feet to left of and 2 feet above road; bolt is marked "U. S. G. S. B. M. 1,834 Ft". 1,828.88

Spring's white house, 200 feet beyond at junction or road to Ponds with main road; square chisel mark on boulder 15x15 by 6 feet in northwest corner or roads 1,808.58

Hamilton County.

McGinn's (John) house, opposite road running south from; square chisel mark on boulder 15 feet to right of and level with road. 1,801.56

Indian river bridge, one-eighth mile east of; near new house; rock 10 feet broad 12 feet to left of and 4 feet above road, marked with circle and "C" also "S. P;" elevation of point in circle. 1,622.20

Indian river bridge, floor of. 1,599.09

Essex County.

MINERVA TO AIDEN LAIR.

Minerva, copper plug set in large boulder at north end of picket fence southeast of Kellogg House; said boulder is about 15 feet to the right of and 1.5 feet above road, and the bolt is marked "U. S. G. S., 1,393 Ft. B. M.". 1,387.840

Minerva, 200 feet east of south of Jones' store; boulder 6 feet to right of and 1.2 feet above center of road, marked with chiseled circle and figures "23". 1,353.96

Minerva, three-fourths mile northwest of and one-fourth mile south of round iron watering trough; boulder 5 feet to right of and 1 foot above center of road, at junction with road leading to left, marked with chiseled circle and " B. M. 24 "........................ 1,432.82

Minerva, one mile northwest of Kellogg House; boulder 10 feet to left of road and 2.1 feet above road mark, chiseled circle and " B. M. 25 feet."................ 1,468.78

Minerva, one and three-fourths miles north of Kellogg House at junction with road to North Woods Club, 80 feet east of south of schoolhouse, copper plub set in outcrop 26 feet to right of and 7.3 feet above center of road, marked " U. S. G. S., 1,742 Ft. B. M."...... 1,736.685

Minerva, two and three-eighths miles north of Kellogg House, summit in road one-eighth mile south of Rockdale; outcrop 10 feet to right of and 1.4 feet above road marked with chiseled circle and " B. M. 28."........ 1,795.76

Minerva, two and five-eighths miles north of Kellogg House and one-eighth mile north of Rockdale; outcrop 20 feet to left of and 5 feet above road, marked with chiseled square................................ 1,800.24

Aiden Lair, two and one-half miles south of and one-half mile south of junction of road to Boreas river (below); outcrop 9 feet to left of and 1.6 feet above center of road, mark, a chiseled circle and " B. M. 34 " 1,960.27

Aiden Lair, 2 miles south of near junction of old Pendleton road to Boreas river; outcrop 8 feet to left of and 1.8 feet above at summit in long rise in road; mark, chiseled circle and " B. M. 35 "............. 1,898.81

Aiden Lair, three-fourths mile south of and 400 feet south of junction of path leading to Balfour pond; boulder 10 feet to right of road at point about 10 feet south of pole culvert; square chisel mark........... 1,797.67

Aiden Lair lodge, 50 feet southeast of; copper plug in boulder, marked "U. S. G. S., 1,659 Ft. B. M."...... 1,653.85

AIDEN LAIR TO NEWCOMB.

Aiden Lair lodge, three-fourths mile from; boulder 6 feet to left of and 1.8 feet above center of road, mark, a chiseled circle and figures "41"................ 1,686.15

Boreas river bridge, 530 feet beyond; square chisel mark on outcrop 8 feet to left and 2 feet above center of road.. 1,632.38

Mile post marked "25 miles to Long lake," 750 feet beyond; square chisel mark on boulder 10 feet to right of and 0.1 foot above center of road, near top of long rise in road.................................. 1,753.25

Kays' house (Wm. L.), one-half mile back from; rock outcrop 9 feet to right of and 1 foot above center of road mark, a chiseled circle and "B. M. 46"........ 1,800.64

Kays' house (Wm. L.), schoolhouse north of; 100 feet west of north of schoolhouse; square chisel mark on outcrop 6 feet to right of and 1 foot above center of road.. 1,701.78

Van der Whacker brook, 175 feet north of; boulder 6 feet to right of and 3.4 feet above center of road, mark, a chiseled circle and figures "48"................. 1,612.84

Van der Whacker brook, outcrop 6 feet to left of and 0.3 feet above center of road at summit of long rise west of; 400 feet back from 23-mile post; mark, a chiseled circle and "B. M. 49" 1,751.85

Twenty-three-mile post, boulder one-half mile north of; [illegible] feet to right of and 1.7 feet above center of road; mark, a chiseled circle and "B. M. 50" 1,753.38

Barron's house (Daniel), 560 feet southeast of; square chisel mark on large boulder 14 feet to right of and 6.3 feet above center of road 1,785.27

Barron's house (Daniel), five-eighths mile beyond; copper plug in large boulder 12 feet to left of and 2.8 feet above center of road, marked "U. S. G. S., 1,737 Ft. B. M." 1,731.946

Tahawus short cut, 1,000 feet back from; opposite barn on right of road; square chisel mark on outcrop 8 feet to left of and 0.2 feet above center of road 1,662.70

Tahawus, one-fourth mile west of fork of road to; square chisel mark on large boulder 7 feet to left of and 2.7 feet above center of road, 60 feet east of bridge over Hyslop brook 1,636.54

Parker's (Samuel), house; square chisel mark on boulder opposite; 12 feet to left of and 3.7 feet above center of road 1,660.06

Nineteen-mile post, three-eighths mile beyond; square chisel mark on boulder 11 feet to right of and 1 foot above center of road at top of small rise 1,653.84

Boles' (Wm.) house, 300 feet northwest of; square chisel mark on large boulder 8 feet to right of and 7.1 feet above center of road 1,674.99

Seventeen-mile post; square chisel mark on boulder near fence in front of log house on right of road.....	1,582.34
Hudson river bridge, square chisel mark on top of coping at down-stream end of west abutment.........	1,562.50
Sibley's garden, west of house; square chisel mark on boulder at southwest corner of, between fence and road..	1,589.30
Newcomb, copper plug in outcrop 85 feet northeast of door of Methodist church, 16 feet to left of and 1.3 feet above center of road, marked "U. S. G. S., 1,640 Ft. B. M."..	1,636.135
Newcomb hotel, one-eighth mile northeast of; square chisel mark on up-stream end of east abutment of iron bridge over creek..................................	1,560.63

NEWCOMB TO HAMILTON—ESSEX COUNTY LINE.

Newcomb hotel, three-fourths mile west of; square chisel mark on boulder 7 feet to right of and 0.1 foot above center of road at end of clearing.................	1,616.42
Cemetery, near summit, one-fourth mile west of; square chisel mark on boulder 7 feet to right of and 25 feet above center of road............................	1,639.96
Beldin's (Abner) house, 460 feet back from; square chisel mark on large boulder 14 feet to right of and 3.8 feet above center of road.......................	1.598.55
Beldin's (Abner) house, copper bolt near on above described boulder, mark "U. S. G. S., 1,603 Ft. B. M."	1,598.304
Schoolhouse, one-fourth mile back from; square chisel mark on boulder 8 feet to left of and 0.4 foot above center of road, 550 feet beyond white frame house on right of road..................................	1,628.60

...ldon's house, one-eighth mile beyond; square chisel mark on outcrop, 6 feet to right of and 1 foot above center of road, 840 feet beyond bridge over brook... 1,580.02

...ly Pad pond; square chisel mark on flat boulder 8 feet to right of and 0.3 foot above center of main road at junction with road................................ 1,671.97

...ssex-Hamilton county line, seven-eighths mile west of of; copper plug in boulder 12 feet left of and 3.5 feet above center of road, marked "U. S. G. S., 1,696 Ft. B. M.".. 1,693.058

INDIAN RIVER BRIDGE, ONE AND ONE-QUARTER MILES EAST OF INDIAN LAKE VILLAGE, VIA. TRAIL TO GOOLEY'S AT, TO MOUTH OF INDIAN RIVER.

...ndian river (Hamilton county) bridge, west abutment; square chisel mark near front angle of coping on upstream end 1,596.61

Main road, one-half mile from; outcrop 40 feet to right of road near small bush surrounded by stones, square chisel mark on southeast end...................... 1,607.72

Main road, one and one-quarter miles from; square chisel mark on boulder 6 feet to right of and 15 feet north of blazed birch tree...................... 1,623.67

Main road, one and one-quarter miles from; square chisel mark on northerly of two boulders 10 feet to right of road.. 1,610 32

Main road, one and three-eighths miles from; square chisel mark on outcrop 5 feet to left of road........ 1,642.22

Essex County.

Main road, one and seven-eighths miles from; square chisel mark on boulder 5 feet to left of and 6 feet northeast of blazed maple tree	1,621.49
Main road, two and one-quarter miles from; square chisel mark on outcrop 6.5 feet to right of and 3 feet above center of road	1,645.23
Main road, two and three-quarters miles from; square chisel mark on slanting outcrop 6 feet to right of and 1.7 feet above center of road in small clearing	1,541.32
Main road, three and three-eighths miles from; square chisel mark on north half of large split boulder 12.5 feet to left of and 8.4 feet above center of road	1,523.78
Hudson river, southwest bank, junction of with north bank of Indian river; circular chisel mark and letter "S" on large boulder	1,423.15

MOUTH OF INDIAN RIVER TO CHAIN LAKES.

Gooley's boathouse, junction of trail from, with west bank of Hudson river; boulder marked with chiseled circle and letter "V"	1,429.16
Gooley's, one-quarter of a mile north of; square chisel mark on boulder 9 feet to left of and 3.7 feet above center of road, 300 feet south of log barn on left of road	1,536.04
Gooley's, three-eighths of a mile beyond; square chisel mark on boulder 5 feet to right of and 2.9 feet above center of road, 260 feet beyond blazed poplar tree marked "A" on right of road	1,569.63

Cooley's, one and one-eighth miles beyond; boulder 5 feet to right of and 3.3 feet above center of road, 8 feet beyond stream, marked with chiseled circle and letter "C" 1,603.65

Cooley's, one and five-eighths miles beyond; square chisel mark on boulder 15 feet to left of and 0.6 feet above center of road, 10 feet southeast of small poplar tree and 12 feet west of south of small fir tree.................................... 1,682.15

Cooley's, one and three-quarters miles beyond; square chisel mark and letter "Y" on boulder 12 feet to right of and 7.3 feet above center of road, at junction with road leading to Mud pond.................. 1,645.05

Cedar river, south bank of 20 feet southwest of ferry on road to Chain lakes; copper plug in outcrop marked "U. S. G. S., 1,549 Ft. B. M."............. 1,543.434

Hamilton County.

Cedar river, one and one-quarter miles beyond; square chisel mark on boulder 9 feet to right of and 4 feet above center of road, 3 feet southwest of blazed maple tree marked "D"...................... 1,563.32

Cedar river, one and seven-eighths miles from; square chisel mark on boulder 6 feet to right of and 2.6 feet above center of road, 7 feet southwest of blazed hemlock.................................... 1,713.83

Chain lakes, third of; copper plug in outcrop 50 feet from and 12 feet above water surface, and 1,100 feet northwest of hotel........................... 1,609.624

MOUTH OF INDIAN RIVER TO NORTH WOODS CLUB.

Hudson river, southwest bank, junction of, with northwest bank of Indian river; copper plug, set in recess at upper sonthwest corner of boulder, marked "U. S. G. S., 1,428 Ft. B. M." 1,422.72

Indian river, five-eighths of a mile from mouth of it; boulder 3 feet to left of and 2.3 feet above center of path and 800 feet east of brook flowing west, marked with chiseled circle and letter "N." 1,643.23

Indian river, 1 mile from mouth of; square chisel mark on outcrop crossing path 6 feet southeast of blazed birch tree 1,677.50

Indian river, one and one-quarter miles from mouth of; square chisel mark and letter "A" on west end of boulder, 12 feet to left of and 4 feet above center of path, 2 feet southeast of one and 6 feet west of a second blazed maple tree 1,643.69

Indian river, one and three-eighths miles from mouth of; boulder 8 feet to right of and 2.7 feet above center of path, marked with chiseled circle "A." 1,636.13

Indian river, one and one-half miles from mouth of; on boulder 5 feet to right of and 2.2 feet above center of path, mark, chisel circle, "B." 1,609.90

Dunk pond, outlet of; boulder in center of path, mark, chisel square 1,545.19

Indian river, 2 miles from mouth of; boulder 4 feet to left of and 1 foot above center of path; mark, chiseled circle and letter "C3" 1,616.40

Indian river, two and three-eighths miles from; square chisel mark on boulder 1 foot to right of and 0.7 foot above center of path, 30 feet north of crossing of brook 1,683.35

Cedar pond trail, junction of path with; boulder 3 feet to left of and 1 foot above, marked with chiseled circle and letter "D2." 1,706.43

Indian river, two and five-eighths miles from mouth of; square chisel mark on southeast end of boulder at brook, 15 feet to left of and 4 feet above center of path 1,703.84

Indian river, two and three-fourths miles from mouth of; boulder 3 feet to left of, and 1.8 feet above center of path; marked with chiseled circle and letter "E1." 1,738.73

North Woods clubhouse, one-half mile back from; boulder at edge of clearing; mark, chiseled circle and letter "F1" 1,779.07

North Woods Club to Moose Pond Club, via Nate Pond.

North Woods clubhouse, boulder 200 feet northeast of; copper plug marked "U. S. G. S., 1,769 Ft. B. M." 1,763.656

North Woods clubhouse, 200 feet northeast of; boulder with copper plug described above, at point marked with chiseled circle and letter "G1" 1,763.70

North Woods clubhouse, one-third mile east of; boulder 6 feet to the left of and 0.8 feet above center of road at end of clearing; marked with chiseled circle and letter "H1" 1,812.38

North Woods clubhouse, three-quarters of a mile east of; boulder 8 feet to left of and 8 feet south of blazed birch tree	1,734.94
Mink pond outlet, 450 feet southeast of bridge over; square chisel mark on boulder 4 feet to left of and 1 foot above center of road	1,700.38
Mink pond outlet, one-quarter of a mile east of; boulder 10 feet to left of and 1.8 above center of road; mark, a chiseled circle and letter "K1"	1,698.53
Mink and Thumb ponds, junction of trail to, with carriage road; square chisel mark on boulder 5 feet to left of and 1 foot above center of road, 12 feet southwest of blazed elm tree	1,644.53
North Woods clubroad, one-quarter of a mile from; square chisel mark on westernmost of two boulders, 15 feet to right of and 1.8 feet above center of path, between two blazed birch trees	1,701.83
North Woods clubroad. one-half mile beyond; square chisel mark on boulder 12 feet to left of and 1 foot above center of path at top of rise 8 feet south of blazed spruce tree	1,717.68
Mink and Thumb ponds, 20 feet west of crossing of path between; boulder 10 feet to right of and 4 feet above center of path	1,685.18
Thumb pond, boulder at edge of at foot of trail from Mink pond, marked with chiseled circle and letters "FF"	1,678.54
North Woods clubroad, one and three-quarters miles from; square chisel mark on east end of boulder in center of and 1.3 feet above trail at junction with trail from right, 15 feet south of blazed birch tree	1,712.22

North Woods clubroad, one and seven-eighths miles from; square chisel mark on boulder in path 30 feet southwest of blazed spruce tree..................	1,721.98
Land line, 50 feet north of crossing of; square chisel mark on north end of boulder 6 feet to left of and 4.2 feet above center of path	1,782.81
Land line, one-quarter mile beyond; square chisel mark on point of boulder in brook to left of and 0.2 feet below center of path, 20 feet northeast of blazed birch tree on right of path and 380 feet beyond old camp on left of path..	1,826.61
North Woods clubroad, 3 miles from; square chisel mark on boulder in path 20 feet west of north of blazed maple tree on right of path................	1,955.48
Nate pond landing, north side of pond; square chisel mark on west end of flat-topped boulder 15 feet southwest of pine tree bearing sign of Moose Pond Club...	2,011.45
Nate pond landing, one-quarter mile beyond; boulder 3 feet to right of and 1.3 feet above center of path, 7 feet east of south of blazed beech tree................	2,105.94
Fish pond, southwest shore of; square chisel mark on boulder at water's edge, to right of path............	2,150.91
Moose Pond clubhouse, 100 feet northwest of; copper bolt in large boulder by shore, marked "U. S. G. S., 2,095 Ft., B. M."............................	2,090.230

MOOSE POND CLUB TO AIDEN LAIR.

Moose Pond clubhouse, one-half mile from; square chisel mark on boulder 25 feet to right of and 2.7 feet below center of road, between two blazed birch trees.	2,068.24

Moose Pond clubhouse, 1 mile from; square chisel mark on boulder 15 feet to left of and 5.7 feet above center of road, 6 feet west of blazed birch and 3 feet southeast of blazed beech	1,840.38
Moose Pond clubhouse, 2 miles from; at junction of carriage road and trail to Aiden Lair; square chisel mark on boulder 3 feet to right of and 1.2 feet above center of road	1,629.76
Moose Pond clubhouse, two and three-eighths miles from; square chisel mark on boulder surmounted by small blazed balsam, 3 feet to right of and 2.2 feet above center of path	1,629.07
Boreas river, one-half mile from; boulder in center and 0.4 feet above path, 6 feet southeast of blazed poplar tree	1,631.63
Boreas river, 800 feet back from; square chisel mark on large boulder 10 feet to right of and 6.5 feet above center of path boulder is marked "X" on side	1,571.52
Boreas river, three-eighths mile east of; square chisel mark on boulder 15 feet to left of and 1.2 feet above center of path	1,616.48
Aiden Lair and Newcomb road, square chisel mark on boulder 30 feet west of south of center of road, 50 feet southeast of Loveland's barn	1,640.48

Hamilton County.

INDIAN LAKE TO CEDAR RIVER.

North river, 500 feet east of 14-mile post from; square chisel mark on boulder 8 feet to left of 2.5 feet above center of road, about 180 feet east of bridge over small stream flowing north	1,682.48

Cedar river, iron bridge over; down stream end of west abutment, square chisel mark....................	1,669.47
North river, 185 feet south of west of 15-mile post from; square chisel mark on boulder 70 feet to right of and 4.5 feet above center of road....................	1,682.78

CEDAR RIVER HOUSE TO WAKELEY DAM.

Main road, three-quarters of a mile from; square chisel mark on boulder 20 feet to right of and 1.7 feet above center of road, 275 feet back from small stream......	1,693.77
Main road, one and three-quarters miles from; square chisel mark on boulder 6 feet to left of and 4.7 feet above center of road..............................	1,743.11
Main road, 3 miles from; square chisel mark on boulder 30 feet to right of and 2.6 feet above center of road, 365 feet back from log house on left of road..	1,772.63
Main road, three and seven-eighths miles from; square chisel mark on outcrop 8 feet to right of and 1.6 feet above center of road, 210 feet back from summit....	1,912.28
Main road, five and one-eight miles from; square chisel mark on large boulder 28 feet to left of and 5.8 feet above center of road, 500 feet back from white frame schoolhouse on right of road....................	1,866.02
Potter's house, three-quarters of a mile beyond; square chisel mark on boulder 21 feet to left of and 2.9 feet above center of road 200 feet north of east of partly log partly frame house on left of road..............	1,875.67
Brown's house, three-quarters of a mile beyond and seven and five-eighths miles from main road; copper plug set in boulder 15 feet to right of and 5.3 feet above center of road, 20 feet north of bridge over small stream flowing to left....................	1,912.618

Brown's house, one and one-eighth miles beyond; square chisel mark on boulder 5 feet to left of and 2.8 feet above center of road 300 feet beyond summit.........	1,959.70
Brown's house, one and seven-eighths miles beyond; square chisel mark on boulder 7 feet to right of and 3.5 above center of road, 50 feet northeast of pole bridge over brook flowing to left..................	2,032.35
Brown's house, two and seven-eighths miles beyond; square chisel mark on boulder 7 feet to right of and 3.9 feet above center of road, 7 feet southeast of blazed beech tree..............................	2,083.98
Wakeley Pond outlet, 12 feet beyond bridge over; square chisel mark on boulder 4 feet to right of and 1 foot above center of road............................	2,092.85
Wakeley dam, copper plug in boulder 25 feet east of north of log house at; marked "U. S. G. S., 2,124 Ft. B. M."..	2,118.804

CEDAR RIVER HOUSE TO FOREST HOUSE.

Fifteen-mile post, five-eighths of a mile beyond; boulder 7 feet to right of and 1.8 feet above center of road, square chisel mark.............................	1,750.17
Sixteen-mile post, one-quarter of a mile beyond; boulder 8 feet to left of and 0.4 feet above center of road, square chisel mark.............................	1,802.96
Seventeen-mile post, one-quarter of a mile beyond; square chisel mark on outcrop 8 feet to left of and 1.4 feet above center of road........................	1,921.43
Seventeen-mile post, seven-eights mile beyond; square chisel mark on boulder 14 feet to left of and 3.6 feet above center of road......................	1,894.62

Eigheen-mile post, one-half mile beyond; square chisel mark on boulder 9 feet to right of and 3.8 feet above center of road	1,891.67
Eighteen-mile post, 1 mile beyond; square chisel mark on boulder 7 feet to left of and 2.8 feet above center of road, 190 feet back from brook flowing to right	1,772.95
Forest House, 19¾ miles from North river; copper plug in outcrop 25 feet to north of west of northwest corner of barroom, marked "U. S. G. S., 1,941 Ft .B. M."	1,936.285

FOREST HOUSE TO BLUE MOUNTAIN LAKE.

Denmark's House, 300 feet southeast of; 30⅝ miles from North river; square chisel mark on boulder 16 feet to right of and 3.4 feet above center of road	1,874.73
North river, 21¼ miles from; square chisel mark on boulder 7 feet to right of and 0.9 feet above center of road	1,774.28
Rock river, bridge over, 21⅝ miles from North river; square chisel mark on downstream end of easterly abutment	1,773.61
North river, 23¾ miles from; square chisel mark on large boulder, 12 feet to left of and 2.4 feet above center of road, at point of crossing of swamp	1,772.28
Blue Mountain Lake House, seven-eighth miles back from; square chisel mark in recess, westerly end of large boulder 7 feet to right of and 2.6 feet above center of road at point 125 feet southeast of junction of main road and road leading to Prospect House	1,785.99

BLUE MOUNTAIN LAKE TO LONG LAKE.

Blue Mountain lake, foundation of new schoolhouse; cross in copper tablet set in second stone from southwest corner of second course from top, marked "1810"	1,804.760
Blue Mountain lake schoolhouse, five-eighths of a mile beyond; square chisel mark on boulder 7 feet to left of and 3 feet above center of road, 65 feet back from watering trough on right	1,939.05
Blue Mountain lake schoolhouse, one and one-eighth miles from; square chisel mark on boulder 15 feet to right of and 0.3 feet above center of road, opposite Duprez's house	2,162.96
Blue Mountain lake schoolhouse, one and five-eighths miles from; square chisel mark on boulder 6 feet to left of and 1.5 feet above center of road, 75 feet beyond small stream flowing to left	2,072.72
Blue Mountain lake schoolhouse, two and one-quarter miles from; square chisel mark on boulder 8 feet to right of and 1.9 feet above center of road about 850 feet beyond brook flowing to left	2,071.66
Bennett's house, three-eighths of a mile beyond; square chisel mark on boulder 8 feet to left of and 1 foot above center of road	1,945.96
Salmon river, one-eighth of a mile beyond; square chisel mark on boulder 6 feet to right of and 2.8 feet above center of road	1,821.09

Salmon river, three-quarters of a mile beyond; square chisel mark on boulder 8 feet to left of and 2.1 feet above center of road, 515 feet beyond small stream flowing to left and 138 paces back from 6-mile post...	1,797.36
Long lake, five and one-half miles from; copper plug in boulder 12 feet to left of and 2.1 feet above center of road, marked "U. S. G. S., 1,855 Ft. B. M."..........	1,850.247
Long lake, four and three-quarter miles from; square chisel mark on boulder 11 feet to left of center of road, 35 feet beyond brook flowing to left................	1,781.59
Long lake, four and one-half miles from; square chisel mark on outcrop 6 feet to left of and 0.4 feet above center of road, 75 feet back from ledge on left.......	1,818.34
Long lake, three and one-half miles from; square chisel mark on large boulder near fence, 500 feet east of South Grove House............................	1,671.21
Three-mile post, 410 feet beyond; square chisel mark on projecting stone at northerly corner of foundation of red-roofed frame house on right of road.	1,727.43
Long lake, one and seven-eighths miles from; square chisel mark on outcrop 7 feet to right of and 2.2 feet above center of road, 100 feet beyond log house on right..	1,670.58
Long lake, one and one-quarter miles from; square chisel mark on boulder 8 feet to left of and 0.7 feet above center of road, 325 feet beyond brook flowing to left..	1,663.62
Long lake, 260 feet west of Sabattis' two-storied frame house; copper plug, set in west end of outcrop, 130 feet to left of center of road, marked "U. S. G. S., 1,663 Ft. B. M."...................................	1,657.769

LONG LAKE TO HAMILTON — ESSEX COUNTY LINE.

Long lake, one-half mile east of; square chisel mark on boulder 11 feet to left of and 7 feet above center of road, 100 feet northeast of Shaw's sawmill..........	1,739.10
Long lake, one and one-half miles east of; square chisel mark on boulder 30 feet to left of and 6 feet above center of road, 125 feet south of east of schoolhouse..	1,780.03
Long lake, two and one-eighths miles east of; square chisel mark on boulder 10 feet to right of and 3.7 feet above center of road, 25 feet beyond plank culvert..................................	1,861.22
Long lake, two and five-eighths miles from; square chisel mark on boulder 8 feet to right of and 3 feet above center of road, 125 feet beyond pole culvert over drain..................................	1,860.53
Long lake, three and three-eighths miles east of; square chisel mark and letter "A" on boulder 12 feet to left of and 2.1 feet above center of road...........	1,874.58
Four-mile post, 35 feet back from; copper plug set in outcrop 14 feet to right of and 2.5 feet above center of road, marked "U. S. G. S., 1,863 Ft. B. M."......	1,857.549
Long lake, four and five-eighths miles from; square chisel mark on boulder 6 feet to right of and 1.7 feet above center of road..........................	1,794.47
Long lake, five and one-half miles east of; square chisel mark on boulder 22 feet to left of and 1.7 feet below center of road, 275 feet beyond small brook flowing to left..................................	1,840.08

Six-mile post, 65 feet east of; square chisel mark on boulder 6 feet to right of and 0.9 feet above center of road.	1,837.89
Seven-mile post, 200 feet east of; square chisel mark on boulder 18 feet to left of and 12 feet above center of road.	1,782.74
Long lake, seven and five-eighths miles east of; square chisel mark on boulder 6 feet to right of and 2.8 feet above center of road, 685 feet east of culvert over small stream flowing to left.	1,749.72

INDIAN RIVER TO U. S. G. S., COPPER BOLT, B. M., SOUTH OF VILLAGE OF INDIAN LAKE.

Indian River bridge, west abutment, up stream end near front angle of coping; square chisel mark.	1,596.61
North river, twelve and one-half miles from; square chisel mark on west end of quartz outcrop 12 feet to right of road, 75 feet east of brook.	1,638.73
Indian Lake village; square chisel mark on long boulder 10 feet to right of road, 250 feet west of top of hill and 10 feet from fifth tree in row north of road, counting from east.	1,728.81
Indian Lake village, one-half of a mile from, on road to Indian lake (Sabael postoffice); west end of smooth, sloping outcrop 75 feet in length, 10 feet from road and 20 feet east of elm tree, 8 inches in diameter, copper bolt, marked "U. S. G. S., 1,793 Ft. B. M."	1,787.638

UTICA SHEET.

The elevations in the following list are based on a bronze tablet set in the masonry wall of the United States postoffice building in Utica, marked "U. S. Geological Survey. Elevation 419 feet. B. M." The elevation of this benchmark above mean sea level is gotten from the nearest permanent benchmark of the State canals. As reduced in accordance with the latest information, the height of this benchmark is 417.516 feet. The leveling was done by Messrs. A. B. Pomme, levelman, and J. G. Tyssowski, rodman, under the direction of Mr. J. H. Jennings, topographer.

Utica Atlas Sheet.

Portions of Oneida and Herkimer Counties.

Utica, Whitesboro and Genesee streets, southwest corner; top of westerly capbolt on hydrant...........	415.69
Utica, D. L. & W. R. R. station; top of doorsill, southeast corner of corner door........................	409.49
Utica, North Genesee street, No. 218; water table southwest corner of brick building......................	410.30
Utica postoffice, bronze tablet west of east basement door, rear of building, marked "U. S. Geological Survey. B. M. Elevation 419 feet".................	417.516
Utica, Webster avenue and Albany street; top of most southerly capbolt on hydrant.....................	495.49
Utica, Albany and Elizabeth streets; top of southerly capbolt of hydrant..............................	462.80
Utica, Albany and Bacon streets; top of most southerly capbolt of hydrant..............................	546.22

Utica, Albany street and Tilden avenue; top of hydrant, "City benchmark, 548.03"	548.41
Utica, Albany street and Welsh Bush road; electric light tower, top of second step from bottom	525.68
Utica, Albany street; starch factory creek; stone arch bridge, north abutment west wing, on northeast corner of top step	523.40
Utica, D. L. & W., and R., W. & O. R. Rs northwest corner of foundation of northwest pier. (New York C. & H. R. R. R. elevation, 406.964)	409.10
Utica, N. Y. C. & H. R. R. R. bridge No. 501, at Starch factory creek; south end of coping, west abutment. Railroad elevation, 404.477	406.66
Utica, North Genesee street; top of south end of west rail, Deerfield street car track	410.25

Town of Frankfort, Herkimer County.

ALBANY PLANK ROAD.

Albany plank road, Herkimer and Oneida county line monument, marked on north side 1889, on east side "H" and on west side "O," the south side being blank; arrow and drill hole on top	695.17
Albany plank road, James McLaughlin's house, top of hitching post in front of	824.94
Albany plank road; road forks east and southeast; highest point on capstone at west side of upper end of culvert	886.78
Albany plank road, on road southeast; nail in wild apple tree 75 feet south of culvert	889.64

Albany plank road, Joseph Cooper's house (occupied by Mr. Easterman); nail in east side of wild cherry tree on east side of road, north of house near fence.......	991.95
Albany plank road, crossing of Marsh road; highest point on southeast corner of capstone of culvert northeast from schoolhouse.......................	984.10
Albany plank road, road west, nail in root of black ash tree, below blaze with three hacks, east side of road..	1,288.89
Frankfort Hill postoffice, southeast corner of piazza opposite road east................................	1,332.10
Stewart's Corners, church, northwest corner of top step at front entrance, 2 inches from building.......	1,351.51

STEWART'S CORNERS TO MOYER CREEK.

Rushmer road, copper bolt in boulder east of first barn east of Stewart's Corners, between third and fourth telegraph poles east of barn, Nos. 9588 and 9587; boulder lies half in road and half in field, and copperbolt is marked "U. S. G. S., 1,380 feet B. M."............	1,378.914
Rushmer road, crossmark chiseled in cornerstone of stone fence, westernmost corner of road coming in from the south................................	1,268.49
Rushmer road, northeast corner of road to north, nail in root of large hard maple tree..................	1,182.89
Brick school house. District No. 8, square chisel mark northwest corner of doorsill........................	1,092.55
Moyer Creek road, John Bouck's house, 600 feet east of; square chisel mark and letters "B. M." on boulder on north side of driveway of road................	1,069.91

Moyer creek gulf road, square chisel mark on top of boulder, with "M" chiseled on south side, near east side of road on side hill, near two small blazed butternuts, and 50 feet north of large blazed butternut with three hacks	997.96
Moyer creek gulf road, bent nail east end of south sleeper of highway bridge north of road forks	909.24
Moyer creek gulf road, Chas. Denslow's house, nail in root of blazed and hacked elm tree opposite	856.27
Moyer creek gulf road, intersection of road west; square chisel mark on south abutment of bridge west wing	634.50
Moyer creek wooden bridge, nail in root of blazed butternut tree east side of road near old barn and abandoned house, 200 feet north of bridge	578.73
Moyer creek iron bridge, square chisel mark on coping of bridge seat, north abutment, east wing	500.71
Frankfort, N. Y., square chisel mark southeast corner of limestone carriage step in front of house on Litchfield street opposite Fourth avenue	433.05

Trenton Plank Road.

Deerfield, J. A. Aurt's brick building, middle door, north corner of stone doorsill	427.87
Trenton plank road, top of stone south of culvert at intersection of Walker road, 10.2 feet south of telephone pole	431.77
Trenton plank road, nail southwest side of telephone pole at intersection of Walker road, 102 feet north of above stone	432.20

Trenton plank road, willow tree east side of road and 180 feet from foot of hill, blazed with three hacks; nail in notch 1 foot above ground..................	462.32
Trenton plank road, blazed telephone pole on top of rise, east side of road and south from drab-colored house, top of nail......................................	531.35
Trenton Falls plank road, at intersection of road running north, top of nail in notch cut in blazed willow tree, two other willows just west of B. M...........	617.63
Trenton plank road, opposite intersection of "Glass Factory or Holland Patent Road;" nail in top of chopped down, blazed and marked telephone pole 1.5 feet south of blazed and marked telephone pole..............	708.00
Trenton plank road, white house opposite road east; bent nail in root of maple tree north of carriage step......	790.03
Trenton plank road, intersection of "Church road;" square chisel mark on stone at south corner, 2 feet east of blazed and marked corner fence post........	809.99
Trenton plank road, Salem Welsh church on road west 600 feet from plank road; square chisel mark on foundation stone at southeast corner..................	816.10
Trenton plank road, South Trenton cemetery, bent nail in root south side of beech tree opposite middle gate..	804.00
South Trenton, copper bolt in boulder north side of road opposite west gate of cemetery, marked "U. S. G. S., B. M. 806 Ft."..................................	804.368

SOUTH TRENTON TO TRENTON RAILROAD STATION.

South Trenton, road crossing one-half mile north of, square chisel mark on stone northwest corner of driveway..	835.90

South Trenton, one and one-half miles north of intersection of Trenton plank road and Holland patent road stone in northwest corner, square chisel mark...... 810.69

Wm. Birdseye's house, opposite fair grounds, top of limestone hitching post, east side of road........... 795.34

R. W. & O. R. R. crossing, 1,500 feet south of at intersection of road running east; shoulder of bottom cornerstone of stone fence in northeast corner. A cross is cut in the face of the stone just under the shoulder. 803.02

Trenton railroad station, watertable 0.42 feet west of south door of waiting room...................... 841.12

Trenton plank road, square chisel mark on stone, over fence, back of telephone pole with bulletin board, opposite road to northwest.......................... 853.91

Trenton plank road, square chisel mark, southwest corner of capstone, south side of culvert over little brook at head of gully................................ 1,019.28

Trenton plank road, road crossing, square chisel mark on boulder in northwest corner 3 feet east of blazed and marked corner fence post..................... 1,212.02

Trenton plank road, square chisel mark on boulder east side of road 350 feet north of edge of woods and 250 feet south of first culvert in woods................. 1,162.78

Trenton plank road, opposite road to northeast, square chisel mark on boulder west side of road........... 1,180.30

Trenton plank road, 500 feet south of T. H. Williams', west side of road; square chisel mark on boulder north of small iron bridge and opposite farm road to northeast 1,001.27

Forest House, square chisel mark on boulder north of barn, opposite hotel.............................. 935.

Trenton plank road, west side of road along telephone line; square chisel mark on boulder opposite road from Forest House.................................. 900.

Trenton plank road, Budwin Jones' house, top of limestone hitching post in front of................... 840.

Trenton plank road, Nine Mile creek bridge; square chisel mark on west bridge seat, north abutment.... 756.

Trenton plank road, South Trenton church, opposite schoolhouse, southeast corner of carriage step, square chisel mark.................................. 807.

SOUTH TRENTON TO NORTH GAGE.

North Gage road, square chisel mark on stone north side of road, opposite road running south............... 823.

North Gage road, intersection of South Trenton road; northwest corner of road crossing, square chisel mark on boulder.................................. 901.7

North Gage road, road north (almost abandoned), square chisel mark on boulder inside of fence, northeast corner 972.1

North Gage, M. M. Schermerhorn's house, top of easterly limestone hitching post....................... 966.2

North Gage church, square chisel mark on southeast corner of stone step.............................. 986.3

NORTH GAGE TO POLAND.

North Gage, east of, first road running north; bent nail in root of hard maple tree in southwest corner of road crossing 945.7

North Gage road, road north to Poland at cheese factory, square chisel mark on stone in northeast corner.....	915.72
Mill road, intersection with Valley road, 300 feet east of covered wooden bridge over West Canada creek, one and one-half miles above Poland; nail in root of apple tree in southwest corner of road crossing..........	720.13
West Canada creek bridge, one and one-half miles above Poland, square chisel mark on south abutment bridge seat, east wing of bridge........................	707.03
West Canada creek iron bridge one-half mile west of Poland; square chisel mark on west abutment, north wing	698.19
Poland, Main street, square chisel mark on west coping, center of stone arch over Cold brook..............	720.70
Poland Free Baptist church, stepping stone, square chisel mark in southeast corner..................	716.12
Poland, railroad depot, spike in telegraph pole opposite. (This is R. R. B. M. Elevation above sea as given by R. R. is 706.752; 703.849 N. Y. C. & H. R. R. R.).....	707.87

POLAND TO COLD BROOK.

Chas. Buck's house, opposite road to village of Cold Brook, southeast corner of piazza..................	788.50
Copper plug in foundation stone, east abutment, north wing of first small iron bridge over Cold brook above (northeast of) Poland, marked "U. S. G. S., B. M. 800 Ft."..	799.147

POLAND TO NEWPORT.

Poland, one-half mile south of; square chisel mark on east abutment, bridge seat, north wing of iron bridge (highway) over West Canada creek................	691.17

Square chisel mark on bridge seat, south abutment, east wing of bridge over small brook, north of and near forks to hill road running southeast................ 683.58

Square chisel mark on stone east side of road south of house (old glue factory) owned by Milo Morey; fence post blazed................................ 682.95

Newport, Main and Norway streets, top of snubbing stone in northeast corner of crossing, square chisel mark...................................... 681.50

Newport National Bank, water table northeast corner of building...................................... 657.81

Newport, stone bridge over West Canada creek; square chisel mark on north coping over center pier....... 656.70

Newport, copper plug set in north coping over center pier of stone bridge over West Canada creek, 6 inches south of square chisel mark and flush with coping, marked "U. S. G. S., 658 ft. B. M."................ 656.70

NEWPORT TO MIDDLEVILLE.

White Creek iron bridge, square chisel mark on south abutement bridge seat, east wing................ 633.0

City brook, square chisel mark on coping stone on south end of east parapet wall of stone arch....... 609.2

Square chisel mark on sandstone boulder on west side of road and north of barn at intersection of Creek road and road from north, opposite A. G. Smith's house...................................... 608.

Canon brook, stone arch over; square chisel mark on coping stone, south end of east parapet wall....... 591.

Middleville, Main and Bridge streets, square chisel mark on northwest corner of stone porch of H. E. and D. G. Jackson's store.........................	584.15
Middleville, West Canada creek, north coping of west abutment of iron bridge, marked " ⊙ B. M. 21 "....	572.51
Middleville, West Canada creek, copper bolt in coping of iron bridge, west abutment, north wing marked "U. S. G. S., B. M. 572 Ft."....................	571.020
Middleville, head of spike in third telegraph pole north of bridge across millrace at dam on west side of creek....................................	374.60

MIDDLEVILLE TO HERKIMER.

Middleville, 1 mile south of; square chisel mark on capstone of culvert on west side of road, south of road west..................................	552.70
Herkimer county poorhouse, square chisel mark in north corner of bottom flagstone, front entrance....	591.36
Countryman's station, one-half of a mile north of; square chisel mark on capstone of culvert on west side of road south of road west..................	549.92
Countryman's station, A. & St. L. R. R. bridge No. 10, square chisel mark on coping stone of north abutment, west wing wall, close to angle..............	492.46
West Canada creek, Dempster's bridge, one-half of a mile north of Kast's bridge; bridge seat, north abutment, west wing, marked " ⊙ B. M."............	473.95
West Canada creek, Kast's bridge (R. R. station), bridge seat, west abutment, north wing, marked " ⊙ B. M."..................................	457.65

Kast's bridge, one-half of a mile south of; square chisel mark on stone west of intersection of Creek road with road running northwest up steep hill........	453.68
Herkimer, German and Lake streets; square chisel mark on stone projecting out of wall, west abutment, south wing of flood bridge.......................	402.52
Herkimer water-works, pump house; northwest corner of doorstep, north door, marked " ⊙ B. M. 5"......	402.18
Herkimer, Albany and Washington streets, top of corner fence post in southwest corner.............	401.31
Herkimer, Albany and Main streets, watertable southeast corner of Manion and Fick's building.........	395.22
Mohawk, closing bench on circuit Utica, South Trenton, North Gage, Poland, Newport, Middleville, Herkimer and Mohawk; W. Erie canal lock No. 42, coping at end of anchor, northeast gate, north lock, marked " ⊙ B. M."............................	397.421

ILION.

Steele Creek aqueduct, Erie canal, copper bolt in center of third coping stone from west end, parapet wall, towpath side, marked " U. S. G. S., B. M. 410 Ft."..	408.964
West Canal street, west end; top of cap, east nozzle of hydrant...................................	403.33
East Main street, top of cap east nozzle of first hydrant east of East street, in front of greenhouse.........	410.06

FRANKFORT TO COPPER PLUG NORTH OF FRANKFORT IN TOWN OF SCHUYLER.

Frankfort, most northerly capbolt on four-nozzle hydrant in front of Central hotel................	414.86

W—t Shore railroad crossing, top of south rail......	400.85
Mhawk River bridge, near Frankfort depot, square chisel mark on bridge seat, north abutment, east wing.......................................	399.04
N. York Central railroad crossing, top of south rail..	400.43
M in root, northeast side of second maple tree on south side of road and west of road from north with "B. & B." telophone line........................	411.03
Hubbing stone southeast corner of road at crossing of road running south with "B. & B" telophone line, square chisel mark..............................	410.05
Square chisel mark on stone back of corner fence post opposite road to East Schuyler church............	418.84
N. on top of corner fence post in northwest corner of road north.......................................	410.19
Square chisel mark on south side of millstone used as carriage step in front of white house opposite road from south.......................................	475.07
Copper plug in boulder southwest corner of road crossing, road from south; marked " U. S. G. S., B. M. 580 Ft."..	579.248
U. S. G. S. iron benchmark post at southwest corner of road crossing road forks, marked " U. S. G. S., B. M. 580"	578.265

Auburn, Skaneateles and Moravia Sheets.

The elevations in the following list are based on a bronze tablet set in the wall of the United States postoffice building at Auburn, which is marked " U. S. Geological Survey. Elevation 710 feet B. M." The elevation of this benchmark above mean sea level is

derived from the nearest benchmark of the State canals. As reduced in accordance with the latest information, the height of this benchmark is 707.941 feet. The leveling was done chiefly by Messrs. A. B. Pomme, levelman, and J. G. Tyssowski, rodman, under the general direction of Mr. J. H. Jennings, topographer.

CASCADE TO SCIPIO

Cascade Hotel, 2 miles west of; square chisel mark on capstone of culvert in southeast corner of intersection of road running south	1,266.97
Cascade Hotel, 3 miles west of; square chisel mark and figures "1351" on stone under horse-chestnut tree in northeast corner of intersection of road running north and south	1,349.03
Cascade Hotel, three and one-half miles west of; square chisel mark and figures "1306" on stone in northeast corner of intersection of road running north and south	1,303.99
Scipio, three-quarters of a mile east of; square chisel mark and figures "1310" on stone in southeast corner of road running east and west	1,308.02
Scipio, square chisel mark and figures "1204" on stone on south side of road about 25 feet west of west line of public school grounds	1,202.03
Scipio public school, 30 feet southeast of corner of; copper bolt in boulder, marked "U. S. G. S., B. M. 1205 Ft."	1,203.554

SCIPIO TO BARBERS.

Scipio, one-half mile west of; stone beside telegraph pole north side of road, opposite large willow tree	1,110.10

. one and one-quarter miles west of; square chisel ..rk and figures "1057" on stone in northwest corner . intersection of road running north and south.....	1,055.00
.. two miles west of; square chisel mark and figures ".043" on stone in northeast corner of intersection of ..d running north and south....................	1,040.80
..oville, Watkin's store; square chisel mark on north..st corner of stepstone..........................	989.64
..ville, one-half mile west of; figures "974" on top of ..ond limestone post east of road running north in ..nt of cemetery................................	971.64
..er's Corners, square chisel mark on mounting block . southeast corner of intersection of road running ..rth and south..............................	862.45
..ber's Corners, 250 feet south of; copper bolt in lime..one boulder on east side of road under apple tree, ..ar bridge, marked "U. S. G. S., B. M. 849 ft."......	847.001

BARBER'S TO LEVANNA.

..er's Corners, one and one-third miles west of; square ..isel mark and figures "679" on stone in northeast ..rner of intersection of road running north.........	676.56
L..anna, square chisel mark and figures "426" on flag..tone in southeast corner of intersection of road run..ing north and south	423.58

LEVANNA TO AURORA.

L..anna, 1 mile south of; square chisel mark and figures "391" on southeast wing of railroad bridge, 200 feet south of road running east...................	388.13

Aurora, northeast corner of water table of bank building north of hotel.............................. 418.1

Aurora, Cayuga Military Academy; copper bolt in west end of door sill, south door of basement, marked "U. S. G. S., B. M., 437 ft."........................ 435.5

LEVANNA TO UNION SPRINGS.

Levanna, one and one-quarter miles north of; square chisel mark and figures "454" on stone near south end of culvert across road running east.............. 450.7

Levanna, 2 miles north of; square chisel mark and figures "469" on boulder in southeast corner of intersection of road running east..................... 466.5

Farley's railroad station, one-quarter mile east of; square chisel mark and figures "430" on stone in southwest corner of road to...................... 426.7

Union Springs, one-half mile south of; square chisel mark and figures "433" on stone 30 feet south of southeast corner of intersection of road running east, 429.6

Union Springs, southwest corner of Main and Factory streets; top of ringbolt in marble hitching post of Murphy's store. 419.2

Union Springs sanitarium, basement door at south end of; copper bolt in west end of doorsill marked "U. S. G. S., B. M. 421 Ft."........................... 418.7

UNION SPRINGS TO AUBURN.

Union Springs, one and one-fourth miles north of; square chisel mark on bottom cornerstone of stone and picket fence, west side of road and opposite road to Auburn, also marked with figures "460"......... 456.4

..a Springs, two and one-half miles northeast of; ..are chisel mark on south end of foundation stone .. southwest corner of intersection of road running ..rth and south. 586.62

.. Acre railroad station, three and one-half miles ..uthwest of; square chisel mark on southeast corner .. mounting block in forks of road running north and ..ad to Auburn. 597.58

.. Acre railroad station, 3 miles southwest of; ..il in root of white ash tree opposite road to east.. 591.61

.. Acre railroad station, two and one-half miles south..st of; square chisel mark and figures "611" on lime..one boulder in line with and opposite south fence of ..ad to west 607.73

..ingport, one-half mile south of; nail in root of tree ..arked "641" at intersection of road............. 637.52

.. Acre railroad station, one and one-fourth miles ..uthwest of; square chisel mark and figures "710" ..n stone near southwest corner of intersection of road ..south.. 706.769

.. Acre railroad station, one-fourth mile south of; ..quare chisel mark and figures "677" on stone in ..orthwest corner of intersection of road to north.... 673.53

..cellius, square chisel mark and figures "648" on ..ounting block in southwest corner of four corners ..d.. 644.48

..rellius, three-fourths miles north of; square chisel ..ark and figures "627" on stone in northwest corner ..f intersection of road to Auburn.................. 623.69

Aurelius, 1 mile east of; square chisel mark and "U. S. G.S., 655" on boulder in southwest corner of intersection of road to south and railroad	652.30
Aurelius, one and three-fourths miles east; square chisel mark on southeast bridge seat of bridge over Crane brook	636.0
Auburn, Lehigh Valley railroad benchmark; bolt in rock 411 feet south of south side of Genesee street on east side of track (R. R. elevation, 647.083)	648.0
Auburn, city benchmark on west end of coping on south side of Genesee street between Sherwood and Delevan streets (elevation 639.12)	643.4
Auburn, Genesee and Washington streets; square chisel mark on limestone boulder at foot of fire alarm pole in northeast corner of intersection of	733.8
Auburn, city benchmark on water table northwest corner of courthouse (elevation 704.79)	709.0
Auburn Savings Bank building, corner Genesee and South streets; northeast corner of second step west corner entrance	690.2
Auburn, North and Market streets; city benchmark top of monument near southwest corner of city hall lot, (elevation 667.91)	671.9
Auburn, Genesee and Seward streets, north nozzle cap of hydrant	768.2
Auburn postoffice building, Genesee street entrance; bronze tablet in top of wing stone at east end of steps marked "U. S. Geological Survey, B. M. elevation 710 feet"	707.9

UNION SPRINGS TO CAYUGA.

n Springs, 2 miles north of; square chisel mark and ures "443" on stone at foot of telephone pole in hwest corner of intersection of road to west.... 439.54

n Springs, 3 miles north of; square chisel mark and ures "430" on stone under maple tree in northeast ner of intersection of road running east and west 427.19

ga, 2 miles south of; square chisel mark and figs "439" on west end of stone in bank south of w York Central railroad, 4 feet east of cattle ard fence, west side of road.................... 435.81

ga; square chisel mark and figures "424" on east stone in northeast corner of intersection of road east in.................................... 421.30

ga, square chisel mark on northwest corner of sill to north door of malt house................ 388.06

ga, Cayuga and Seneca canal, Lock No. 10; copper ld between anchors of west wing of south gate (elevation of canal B. M., 390.813); marked "U. S. G. S., B. M. 392"................................... 390.666

AUBURN TO FLEMING AND SCIPIO.

rn, Genesee street, 2 miles south of, on Lehigh alley railroad; iron bolt in box culvert 911 feet orth of north side of public road (elevation 720.440). 721.36

rn, 3 miles south of; square chisel mark on orth end of stone culvert east of intersection of road o south.................................... 729.90

Fleming, one and one-half miles north of; square chisel mark and figures "765" on stone at east end of culvert north of road to east........................ 761.83

Fleming, one and one-quarter miles north of; square chisel mark and figures "779" on capstone south end of culvert across road to east	775.[illegible]
Fleming, one-half mile north of; square chisel mark on east side of stone in grass plot at intersection of road to west	873.[illegible]
Fleming, Methodist Episcopal church; copper bolt in doorstep or watertable, south door, marked "U. S. G. S., B. M. 912 Ft."	910.[illegible]
Fleming, 1 mile south of; square chisel mark on boulder on east of road about 4 feet from locust tree, a little south of a brick house on west of road..	921.[illegible]
Fleming, 2 miles south of; square chisel mark on white-washed stone horse block, in front of wood-colored house west of road............................	959.5
Scipio, 3 miles north of; square chisel mark on rough stone horse block in front of white house on southwest corner of road intersection......................	1,070.7
Scipio, 2 miles north of; square chisel mark on boulder on east side of road in front of white house in front of which is a walnut tree..........................	1,196.1[illegible]
Scipio, 1 mile north of; square chisel mark on boulder near fence line on west side of road, about 600 feet south of summit................................	1,247.3[illegible]

AUBURN TO SKANEATELES.

Auburn, one and one-quarter miles east of; square chisel mark and figures "841" on boulder in southeast corner of intersection of road south.................	838.9[illegible]

Auburn, 3 miles east of; square chisel mark and figures "881" on capstone at west end of culvert across road to south 879.52

Auburn, three and one-quarter miles east of; square chisel mark and figures "952" on boulder at telephone pole, west of intersection of road to south 950.36

Auburn, 4 miles east of; figures "921" on boulder at telephone pole in northwest corner of intersection of road to north 918.70

THROOPSVILLE TO CAYUGA.

Throopsville, one and three-quarters miles east of; Lehigh Valley Railroad benchmark on iron bolt in stone foundation of culvert 201 feet north of point of switch (elevation, 545.368) 546.281

Throopsville, grindstone used as horseblock in front of small yellow house near corner 1,000 feet east of mill 531.43

Throopsville, Owasco outlet near gristmill, floor of bridge across 493.18

Throopsville, square chisel mark on southeast corner of stone horse block north side of road just east of four corners 516.59

Throopsville, one-half mile west of; top stone of culvert under north end of highway east of road to north 521.99

Throopsville, one and three-quarters miles west of; square chisel mark on rock, west side of road near red barn two-fifths of a mile west of brick schoolhouse 536.55

Throopsville, 2 miles west of; floor of iron bridge across Crane brook....	485.05
Fosterville, 1 mile east of; square chisel mark on stone foundation of small wooden bridge, south end......	508.41
Fosterville, three-quarters of a mile east of; iron peg opposite telephone pole No. 13,092....	563.56
Fosterville, one-half mile east of; highest point of granite boulder near south fence 60 feet west of well near road north....	520.13
Fosterville, 1 mile west of; floor of iron bridge near road to north....	489.71
Fosterville, one and three-quarters miles west of; south-east corner of north wall of stone culvert about 500 feet east of road to north....	485.51
Fosterville, 3 miles west of; square chisel mark on granite boulder horseblock in front of wood colored house south side of road 800 feet east of canal.....	409.09
Cayuga, one and three-quarters miles north of; nail in stub of small blazed elm tree west of towpath of Cayuga canal and north of second telephone pole north of road to Fosterville....	390.0

SKANEATELES, N. Y.

Lake Shore; projecting stone in retaining wall west of steamboat landing, marked "1843"....	864.6
State dam, outlet of lake; crest at east end of dam....	866.
Syracuse water-works inlet; southwest corner of door-sill, front entrance of gate house....	873.
State dam; copper bolt in first step from top, west wing wall, marked "U. S. G. S., B. M. 870 ft."....	868.

Genesee and Onondaga street; northerly capbolt of hydrant 926.94

Genesee and East Lake streets; upper rim of south nozzle-cap of hydrant 981.08

SKANEATELES TO GLEN HAVEN, ROUTE ON WEST SIDE OF LAKE.

Skaneateles, one and one-quarter miles west of; stone culvert, square chisel mark on east coping stone, north parapet 984.18

Auburn, five and one-half mile-post from; road crossing north from; square chisel mark on stone in southeast corner 997.85

Auburn road and road to Baptist Four Corners, culvert 215 feet south of intersection, square chisel mark on coping of west parapet wall 976.50

Baptist Four Corners, one and three-quarter miles north of; square chisel mark on capstone west end of culvert north side of road crossing 1,017.57

Baptist Four Corners, 1 mile north of; square chisel mark on boulder on west side of road 12 feet south of hedge and wire fence corner, a little south of house surrounded by evergreen and apple trees on east side of road 1,042.82

Baptist Four Corners, south of Baptist church sheds; nail in notch cut in root of ash tree 1,018.10

Baptist Four Corners; square chisel mark on snubbing stone in southeast corner of crossing of road leading to church 1,007.18

Baptist Four Corners, one and one-quarter miles south of; square chisel mark on stone east side of road, west side of locust tree and outside of fence, about 50 feet north of intersection of road from west............	934.97
Baptist Four Corners, 2 miles south of; square chisel mark on east keystone of road culvert about 100 feet north of road from west..........................	878.97
Owasco, brook north of; square chisel mark on northwest seat of iron bridge........................	798.82
Owasco, snubbing stone north side of road and about 100 feet east of four corners......................	892.93
Owasco, bridge one-quarter mile southeast of; top of southeast corner post of railing..................	857.41
Owasco, one-quarter mile southeast of on road to "Twelve Corners;" copper bolt in fifth foundation stone from south end of dry wall on east side of north approach to small iron bridge, marked "U. S. G. S., B. M. 853 ft.".................................	851.018
Owasco, 1 mile from; square chisel mark on stone east side of road running north and south, and opposite road from................................	963.51
Owasco, one and one-half miles from; square chisel mark on stone east side of road, on line with north fence of road from east; an Italian poplar in southeast corner of intersection of the two roads.........	1,063.07
Owasco, 2 miles from; square chisel mark on north wing stone, southwest end of culvert at forks of road.	1,177.34
Owasco, two and three-quarter miles from; square chisel mark on stone west side of road opposite road from east	1,277.77

Owasco, 3 miles from; iron bridge over small brook at intersection of road from the west, square chisel mark on northeast bridge seat.................... 1,235.00

"Twelve Corners," crossroads at schoolhouse; square chisel mark on stone at west end of culvert......... 1,375.26

"Twelve Corners," house in northeast corner of road crossing; square chisel mark on boulder in front yard. 1,393.37

"Twelve Corners," on first hill south of; stone in fence, west side of road, about 100 feet north of gate and north of blazed fence post........................ 1,464.46

"Twelve Corners," one and one-quarter miles southeast from; square chisel mark on boulder east of east fence of road and 25 feet north of the north line of road coming in from the west 1,449.32

"Twelve Corners" to Kelloggsville, intersection of road with Valley road running north and south; square chisel mark on capstone at west end of culvert...... 1,172.43

Kelloggsville, Main street and Hill road; snubbing stone in northwest corner of crossing............. 1,422.53

Kelloggsville, stone culvert over small brook north of intersection of Main street and Hill road; square chisel mark on coping stone near center of east parapet wall. 1,416.60

Kelloggsville, opposite road from "Twelve Corners;" coppper bolt in boulder west side of maple tree and scales in front of W. D. Sayles' store, marked "U. S. G. S., B. M. 1,424 ft."........................... 1,422.617

Kelloggsville, 1 mile south of, opposite road running west; square chisel mark on north cornerstone of gateway in stone fence................................ 1,545.74

Kelloggsville, one and one-half miles south of; square chisel mark on capstone at west end of culvert across road at north line of road running east............	1,567.60
Sayles Corners; square chisel mark at south end of culvert across road from east.........................	1,588.80
Sayles Corners, one-half mile southwest of; nail in trunk of small blazed and hacked locust tree on west side of road, opposite center of road running east.........	1,444.43
Wilsons Corners, top of retaining wall of approach to upper story of blacksmith shop; square chisel mark in limestone boulder	1,092.70
Sayles Corners, three-quarters of a mile southeast of; nail in east side of maple stump, northwest corner of intersection of road from the west................	1,556.88
Sayles Corners, three-quarters of a mile southeast of; square chisel mark on bottom cornerstone of fence, southeast corner of intersection of road running south; a large ash tree stands near the southeast corner and a basswood in the southwest corner........	1,565.37
Sayles Corners, 1 mile southeast of; square chisel mark on boulder in northeast corner of crossing of road running east	1,704.38
Sayles Corners, 2 miles southeast of; square chisel mark on stone west of first fencepost west of northwest corner post of intersection of road from the north	1,756.49
Bear swamp, just west of; square chisel mark on stone on north side of grass plot between east and west fork of road from the south	1,781.78

Glen Haven, road running north and south to; square chisel mark on stone opposite road from Sayles Corners, just east of Bear swamp....................	1,573.20
Glen Haven; square chisel mark on south cornerstone of gateway in fence opposite road running east four miles to	1,663.97
Glen Haven, 4 miles from, in abandoned road; square chisel mark on stone in most westerly wheel track 50 feet southeast of traveled road running east and 15 feet east of twin appletree west side of road........	1,668.11
Glen Haven, 2 miles south of; nail in south root of blazed and hacked butternut tree on west side of road and 75 feet north of road from hill....................	1,272.19
Skaneateles lake, bridge over south inlet at intersection of roads southwest and north and south; square chisel mark on stone three feet east of southeast bridge seat.	977.65
Spafford, north line of road running east to; nail in north root of hard maple tree on west side of road opposite to	883.43
Glen Haven, iron bridge at south inlet of Skaneateles lake; square chisel mark on northwest bridge seat..	870.44

MARCELLUS STATION TO MARCELLUS.

Marcellus Station, road culvert west of; southeast corner of south coping stone on south wing wall........	433.02
Limekiln, bridge across millrace opposite; square chisel mark on coping stone on north end of northeast wing wall	471.96
Marcellus Falls, at road running east, stone arch over creek below; square chisel mark on coping stone, west end of north parapet wall........................	514.61

Marcellus Falls, floor of iron bridge..................	539.49
Marcellus Powder Company, opposite north end of at intersection of road running northeast; square chisel mark on boulder east side of road..................	622.81
Marcellus Powder Works, iron bridge south of; square chisel mark on southeast bridge seat...............	612.47
Marcellus, North Street Presbyterian Church; southeast corner of southerly mounting block............	671.78
Marcellus, stone arch over Otisco lake outlet (Nine Mile creek); square chisel mark on coping stone, north parapet wall	652.65
Marcellus, Main street, stone arch over Otisco lake outlet (Nine Mile creek); copper bolt a little west of center, in fourth coping stone east from angle at west end of north parapet wall marked "U. S. G. S., B. M. 655 Ft."..	652.657

SKANEATELES TO BORODINO.

Skaneateles, one and three-quarter miles east of; square chisel mark on boulder west of elm tree on north side of road at forks of road, one running west and the other west southwest........................	951.11
Skaneateles, three miles east of; square chisel mark on stone in southwest corner of road crossing, north of west parapet wall of pipe culvert under road from the south	1,008.71
Skaneateles, three and one-half miles east of; square chisel mark on stone in southeast corner of intersection of road running south at schoolhouse..........	1,104.33
Clintonville, northwest corner of intersection of road running north; square chisel mark on stone near well.	1,065.36

Clintonville, culvert under road from south; square chisel mark on stone at southeast end.............. 1,088.79

Clintonville, one mile south of; square chisel mark on boulder, east side of road and opposite road running west.. 1,178.25

Marietta, road from, to Rose Hill; square chisel mark on piece of flagging, at intersection of, in southeast corner.. 1,269.06

Marietta hotel, at corner of roads to Clintonville and Rose Hill; square chisel mark on foundation stone north corner of piazza.............................. 797.57

Otisco lake State dam, highway bridge below on road from Marietta to Amber; square chisel mark, southwest corner of bridge seat........................ 778.28

Otisco lake outlet, State dam; crest of spillway at west end, close to gate chamber........................ 784.08

Otisco lake outlet, State dam; square chisel mark near southeast corner of north coping stone, east wing wall, 787.60

Otisco lake outlet, State dam; copper bolt in south coping stone of east wing, marked "U. S. G. S., B. M., 789 ft.".. 787.650

Rose Hill and Thorn Hill, large boulder east side of road midway between; square chisel mark.......... 1,257.04

Thorn Hill, three-quarters of a mile south of; square chisel mark on limestone boulder, east side of road, opposite center of road running west.............. 1,199.22

Thorn Hill, one and three-quarters miles south of; square chisel mark on stone at east end of culvert, about 50 feet north of intersection of road running east and west.................................. 1,061.75

Borodino, one mile north of; square chisel mark on stone at south end of culvert across road running east.....	1,015.79
Borodino, nail in stump of flagstaff near lamp-post at four corners....................................	1,107.89
Borodino, top of ringbolt in mounting-block in southwest corner of four corners........................	1,106.18
Borodino, Thorn Hill road, 215 feet south of intersection of first road running east from; copper bolt half mile north of, in sandstone boulder on east side of driveway, marked on north side "B. M.," with chisel; marked "U. S. G. S., B. M. 1021 ft"................	1,019.058

GLEN HAVEN TO BORODINO.

Glen Haven hotel, two miles east of; nail in notch cut in root on south side of twin cherry tree east of sharp bend in road from north to east..................	1,391.05
Glen Haven, intersection of road running west to and road running north to Spafford; northeast side of first tree (a maple) north of, nail in notch cut in root. The tree is further distinguished by anchor-shaped mark on north side about five feet from the ground..	1,644.16
Spafford, one-half mile south in Bruce Norton's lot; copper bolt east side of road and 200 feet from fence on bank of small brook, marked "U. S. G. S., B. M., 1,654 ft."..	1,652.327
Spafford, water-table at southeast corner of church in northwest corner of roadcrossing.................	1,693.24
Spafford, first road running west north of; square chisel mark in southwest corner of large laminated boulder in southwest corner..............................	1,740.47

Spafford, 3 miles north of; square chisel mark in capstone, north end of pipe culvert across road from the east.	1,587.81
Spafford, 3 miles north of; square chisel mark in capstone of northwest wing of pipe culvert 150 feet south of road running west	1,575.36
Borodino, one and one-quarter miles southeast of; square chisel mark on limestone boulder on west side of road lying just outside of wheel track and 50 feet north of road running west	1,420.15
Borodino, 1 mile southeast of; bent nail in south root of hard maple tree in grassplot between north and south fork of road from the east	1,402.98

WILSON'S CORNERS TO MORAVIA.

Wilson's Corners, one-half mile south of; nail in lower crotch of small apple tree in northeast corner of intersection of road east	1,068.52
Grist-mill, north of blacksmith shop, in northeast corner of road running east, west step-stone to stairs, marked — "917" with chisel	915.04
Moravia, cemetery; square chisel mark on limestone between two roads to south opposite main entrance.	877.50
Moravia, East Cayuga and Factory streets; east cap-bolt of hydrant	762.58
Moravia, Cayuga and Main streets; east cap-bolt of hydrant	742.75
Moravia, Main and Church streets; north cap-bolt of hydrant	744.14

Moravia, "Moravia House," corner Cayuga and Main streets; cross mark of bronze tablet in northeast corner of foundation, marked "U. S. Geological Survey, B. M. elevation, 743 feet"	740.841
Moravia, Church street, at top of Schoolhouse hill; capstone at north end of culvert, square chisel mark.	871.26

LEHIGH VALLEY RAILROAD.

Moravia depot, 300 feet south of; iron bolt on southwest abutment of plate girder bridge over Main creek (railroad elevation, 731.560)..................	732.62
Locke Station, railroad bridge over Owasco inlet, 3,260 feet north of; iron bolt cemented in southeast abutment (railroad elevation, 781.085).................	782.19
Peruville Station, spike in pine tree, 2,047 feet north of north end of and 52 feet west of railroad track (railroad elevation, 1,040.010)....................	1,041.09

MORAVIA TO CASCADE.

Owasco inlet, near bridge over; most northerly tree (maple) in front of dwelling on road running north and south, and facing road from Moravia running east, nail in north root..........................	732.86
Cascade hotel, south end of Owasco lake; northeast corner of water tank, marked "728, U. S. G. S.".....	725.56
Cascade hotel, square chisel mark on stone west side of road running north and south at intersection of road running southeast from; marked with the letters "U. S. G. S."............................	1,108.28

Cascade hotel, one and one-fourth miles northwest of; copper bolt in limestone boulder 10 feet southwest of bridge over small brook on road running north and south.................................... 1,088.681

MORAVIA TO PERUVILLE, VIA DRESSERVILLE AND MCLEAN.

Moravia, one mile east of; nail in east root of hard maple tree in northwest corner of intersection of road running north............................ 1,116.16

Moravia, three miles east; square chisel mark on southwest corner of foundation stone of barn opposite road running south; also marked "1,117 U. S. G. S." on stone above......................... 1,114.70

Moravia, three and one-quarter miles east of; boulder marked "U. S. G. S." with chiseled square, lying north of fence and west from cherry tree in northwest corner of intersection of road running north... 1,152.09

Dresserville, intersection of road running southeast to and road running east and west; square chisel mark on southeast bridge, seat of bridge at........ 1,113.00

Dresserville, one mile north of; square chisel mark on stone in southeast corner of road running east, 12 feet south of small elm tree.................... 1,215.84

Dresserville, Kenyons or Tannery lower dam; square chisel mark on eighth step from top of east wing.... 1,279.92

Dresserville, bridge at blacksmith shop and gristmill; square chisel mark on top stone of north abutment at northeast corner of............................ 1,289.91

Dresserville, George Fitz's saw and grist mill; copper bolt in west end of doorsill to south door of boiler-house, marked "U. S. G. S., B. M., 1291 feet"......	1,287.789
School house in southeast corner of intersection of road running east and west; square chisel mark on stone with figures "1399"............................	1,397.14
Lake Como, nail in notch cut in north root of balsam tree in front yard of house in northeast corner of intersection of road running east and across inlet to......	1,347.42
Lake Como, water level...........................	1,306.16
Lake Como, opposite; square chisel mark with letters "U. S. G. S.," and figures "1336" on stone at foot of southwest wing-wall of small bridge, 100 feet north of intersection of road running west...............	1,333.50
Lake Como, south end of; nail in notch cut in west side of apple tree, east side of road, opposite road running southwest....................................	1,344.99
Fall Creek, bridge over, 200 feet east of road running north and south, on road running east; square chisel mark on stone southeast corner of abutment........	1,305.2
Lake Como, first four corners south of; square chisel mark, with figures "1334," on stone near southwest corner of road crossing, 27 feet west of west wheel track of road running north and south, and 35 feet south of center of road running east and west.......	1,332.0
Church on west side of road, snubbing stone at northeast corner of platform in front of; square chisel mark with letters "U. S. G. S.," and figures "1429"......	1,426.3

Groton City, two and one-quarter miles north of; Fall Creek bridge, square chisel mark on capstone of west abutment, north wing..........................	1,293.29
Groton City, two miles north of; square chisel mark, with letters "U. S. G. S.," and figures "1334," on boulder in southwest corner of intersection of road running east and west..........................	1,331.33
Groton City, one mile north of; square chisel mark with figures "1310," on stone on west side of road, 25 feet north of north line of road coming in from west.....	1,307.93
Groton City, one-quarter mile north of farm of George A. Bliss; copper bolt in boulder 150 feet east of dwelling-house, and 125 feet east of road, marked "U. S. G. S., B. M., 1372 feet"..........................	1,369.582
Groton City, southwest corner of road south to McLean, east of Fall creek; square chisel mark with figures "1290" on snubbing stone..........................	1,288.01
Groton City, Fall creek bridge, iron bolt in south bridge seat, east abutment..........................	1,273.00
Groton City, one mile south of; bent nail in notch cut in west root of maple tree, southeast corner of road running east and west. Tree has signs nailed to it and is marked in a blaze, "1262"..........................	1,259.91
Lafayette, south end of culvert on road running east and about 150 feet east of intersection of road running north and south, capstone marked with square chisel mark, and the figures "1251"..........................	1,249.21
Nubia post-office, bent nail in notch in root on south side of hard maple tree, 75 feet south of road running east and west..........................	1,251.92

Nubia post-office; square mark and figures "1236" on south truss, on top of hanger of first joint west of center of bridge over Fall creek......................	1,233.56
Nubia post-office, one and one-third miles southwest of; square chisel mark with figures "1201" on millstone used as mounting block in front of house in northwest corner of intersection of road running east and west..	1,198.67
McLean, one mile northwest of; square chisel mark on capstone at east end of culvert on north side of road coming in from the west..........................	1,179.58
McLean, corner of West and Mill streets; nail in east side of maple tree in southwest corner of intersection.	1,135.07
McLean, east wall of millrace north of small bridge at west side of the square and south of the store and post-office; square chisel mark, with legend "U. S. G. S., 1123"...................................	1,120.12
McLean, North street, east side of; copper bolt in boulder opposite upper part of graveyard, and 60 feet south of four evergreen trees planted in graveyard on a straight line with the road fence, stone is marked "U. S. G. S.," on west side, marked "U. S. G. S., B. M., 1234 Ft."..	1,231.853
McLean, one and three-quarter miles west of; square chisel mark with figures "1380" on snubbing stone in northeast corner of crossing of road running north and south..	1,377.74
McLean, two and one-quarter miles west of; square chisel mark with figures "1275" on boulder near southeast corner of intersection of road running south..........	1,272.64

Peruville station, three-quarter mile east of; square chisel mark with figures "1142" on snubbing stone in southwest corner of intersection of road running south	1,139.87
Peruville station, iron highway bridge about 200 feet east of; square chisel mark with legend "U. S. G. S.," and figures "1030" on southeast bridge seat..........	1,027.43
Peruville station, one-third mile west of; square chisel mark on small stone six feet west of the northeast corner of intersection of road north and south......	1,104.75
Peruville, one-quarter mile south of; square chisel mark on northeast bridge seat, small wooden highway bridge	1,257.84

PERUVILLE TO MORAVIA VIA NORTH LANSING.

Peruville, one-half mile southwest of; square chisel mark on cornerstone, with legend "U. S. G. S., 1322," in southwest fence corner of road running south....	1,319.73
Peruville, one mile southwest of; square chisel mark with figures "1314" on stone on south side of road near small ash tree, opposite intersection of road....	1,311.76
Peruville, one and one-quarter miles west of; square chisel mark with figures 1364 on stone in southwest corner of intersection of road from south...........	1,361.17
Peruville, two and one-quarter miles west of; square chisel mark with legend "U. S. G. S., 1400" on southeast corner of stone step to front entrance of school house in southeast corner of intersection of road running south..	1,397.23

Benson's Corners, one and one-quarter miles south of; square chisel mark on stone in northeast corner of intersection of road running north................	1,271.46
Benson's Corners, one-half mile south of; chiseled square with letters "U. S. G. S." on stone 300 feet north of road running east and west...............	1,294.07
Benson's Corners, one-third mile south of; copper bolt in boulder in east fence under most northerly of four butternut trees nearly opposite farmhouse, marked "U. S. G. S., B. M., 1,320 ft".....................	1,318.270
South Lansing hotel, two and three-quarter miles east; square chisel mark with figures "1,201" on most southerly capstone of culvert 100 feet east of road running north and south................................	1,198.72
South Lansing hotel, 2 miles east of; square chisel mark and figures "1,145" on highest point of boulder on south side of south fence opposite to and west of northwest corner of intersection of road running north	1,141.88
South Lansing hotel, three-quarters mile east of; square chisel mark and figures "956" on stone in northeast corner of intersection of road running to North Lansing...............................	953.24
Midway, one-third mile north of; nail in root of first horse chestnut tree on west side of road north of road running east and west...........................	956.77
Midway, 1 mile north of; square chisel mark and figures "986" on southwest bridge seat of small iron bridge about 200 feet south of road running east and west..	983.48

North Lansing, 2 miles south of; square chisel mark and figures "1,051" on snubbing stone in northeast corner of intersection of road running east............	1,047.99
North Lansing, one and one-half miles south of; square chisel mark and figures "1,016" on stone in southwest corner of intersection of road running east and west.	1,013.44
North Lansing, 1 mile south of; shop in northwest corner of intersection of road running east and west, square chisel mark and figures "938" on southwest corner of stone step, front entrance................	935.89
North Lansing, one-half mile south of; square chisel mark on boulder in southeast corner of intersection of road running east and west....................	913.23
North Lansing, R. Beardsley's store at intersection of roads; square chisel mark and figures "1,005" on snubbing stone at southeast corner................	1,002.27
North Lansing, R. Beardsley's store; marked "U. S. G. S., B. M., 1,005 ft" post south of and close to building.	1,002.360
North Lansing, 1 mile east of; square chisel mark on snubbing stone at northwest corner of intersection of road running north and south..................	963.81
Locke, 3 miles southwest of; bridge at crossroads, square chisel mark, figures "944" and legend "U. S. G. S." on southeast bridge seat of.................,	942.01
Locke, two and one-quarter miles southwest of; square chisel mark, with chiseled cross just below, on stone on east side of road 125 feet south of intersection of road from the east....................................	933.30

Locke, 2 miles southwest of; nail in root of hard maple tree at intersection of road running southwest and up hill 903.18

Locke, one and one-half miles southwest of; square chisel mark on northwest bridge seat of wooden bridge 50 feet south of main road on road to West Groton 897.13

Locke, one and one-quarter miles southwest of; nail in notch cut on east side of small elm tree, in west fence and 50 feet south of intersection of road running west; tree is blazed and marked "892" 890.40

Locke, one-half mile south of; square chisel mark on stone outlet to drain of house opposite road running south 815.37

Locke, George Culver's store, corner of Main and Mill streets; square on top of curbstone marked in front "U. S. G. S., 795" 793.45

Locke, one-half mile north of; square chisel mark on stone east end of culvert at intersection of road from east 794.27

Moravia, one and one-quarter miles south of; nail in root of butternut tree blazed and marked "761" at north-east corner of road running southeast.............. 759.10

MEDINA, ALBION, LOCKPORT, RIDGEWAY, OAK ORCHARD AND OLCOTT SHEETS.

The elevations in the following list are based on a bronze tablet set in the foundation stones of the Orlean House at Albion, which is marked "U. S. Geological Survey. Elevation 521 feet. B. M." The elevation of this benchmark above mean sea level is based on the nearest State canal benchmark. As reduced in accordance

with the latest information the height of this benchmark is 518.949 feet. The leveling was done by Messrs. E. L. McNair, levelman, and Farley Gannett, rodman, under the general direction of Mr. Frank Sutton, topographer.

Medina Atlas Sheet.

Orleans County.

Shelby town, Coons bridge, 125 feet north of; copper plug on top of boulder 3 feet high, east side of road between East and West Shelby, marked "U. S. G. S., B. M., 616 ft."	614.636
East Shelby, copper plug in boulder at southwest corner of Methodist Episcopal Church marked "U. S. G. S., B. M., 668 ft."	666.427
Medina. Prospect street bridge; No. 140, lower step east end, north side of Erie canal	516.10

Genesee County.

Wheatville, copper plug in granite boulder under northwest corner of red barn on land of John Waterstreet, 200 feet north of road crossing and 3 feet east of fence line marked "U. S. G. S., M. B., 669 ft."	667.062
Alabama town, copper plug in second step east abutment north side of gate at entrance to canal feeder marked "U. S. G. S., B. M., 622 ft."	620.040
East Pembroke, top of rail in front of station, New York Central and Hudson River Railroad	880.10
East Pembroke, one mile north of; copper plug in boulder 6 feet square deeply imbedded in ground on east side of north and south road, 630 feet north of corner, on land belonging to E. H. Clark marked "U. S. G. S., B. M., 873 ft."	871.119

Pembroke railroad station, 1,550 feet east of; on bridge No. 104, Batavia and Tonawanda branch of the New York Central and Hudson River railroad; copper plug in coping stone of east abutment, south side of track marked "U. S. G. S., B. M., 823 ft." 821.759

Niagara County.

Middleport, Erie canal bridge No. 145; cross mark on bronze tablet in north foundation, under center of bridge and facing towpath and canal, marked "U. S. G. S. Elevation, B. M., 519 ft." 517.255

ALBION ATLAS SHEET.

Orleans County.

Barre town, E. E. Allis' house, north side of first road east, north of West Barre, on road to Eagle harbor, three-quarters mile east of north and south road; copper plug in lower of three stone steps before eastern front door, marked "U. S. G. S., B. M., 666 ft." .. 664.184

South Barre, copper plug in stone doorsill of District Schoolhouse No. 9, 220 feet east of road crossing, marked "U. S. G. S., B. M., 652 ft." 650.525

Albion, Orleans house, corner of Platt and Bank streets, bronze tablet in Platt street side 40½ feet from Bank street corner, 7.7 feet from office door, marked "U. S. G. S., B. M,, elevation 521 ft." 518.949

Holley, Erie canal bridge No. 115, Webster warehouse south and west of; copper plug in doorsill of only door on canal side, marked "U. S. G. S., B. M., 514 ft." 512.225

Clarendon Town, opposite Andrew Kuhn's house on land belonging to Mrs. Butcher one-third mile north of county line; copper plug in granite boulder marked, "U. S. G. S., B. M. 648 ft." 646.017

Genesee County.

Elba town, copper plug in granite boulder 2.6 feet high at southwest corner of junction of east and west road and road south. The east and west road is the first road north from Langton Corners, and the north and south road is the first one turning north going east from Langton Corners, marked "U. S. G. S., B. M., 675 ft." 673.517

Elba town, East Oakfield, one and one-half miles east of; copper plug in boulder 65 feet southeast of District Schoolhouse No. 9, 15 feet from road corner on west side of north road, marked "U. S. G. S., B. M., 709 ft." 707.023

Byron, 1,710 feet west of railroad station; copper plug in next to upper step of large culvert across Black creek, north of New York Central and Hudson River Railroad Company's tracks and 27 feet from center of north track, marked "U. S. G. S., B. M., 682 ft." .. 680.144

OAK ORCHARD ATLAS SHEET.

Orleans County.

Gaines town, W. H. Banker's house on west side of transit road, 600 feet north of Murray and Gaines Baptist Church; copper plug in stone 3 feet square and 1½ feet high in door-yard on south side of and 12 feet from dwelling, marked "U. S. G. S., B. M., 458 ft." 456.103

Murray, 610 feet north of road crossing on west side of road, 81 feet southwest of stone schoolhouse; copper bolt in boulder 3 feet wide, 2 feet high, marked "U. S. G. S., B. M., 410 ft."	408.458
Fairhaven, 1,200 feet south of, on east side of road to Albion; copper bolt in top of stone ,masonry wall, in front of Mrs. Dixon's house, marked "U. S. G. S., B. M., 439 ft."	437.171

RIDGEWAY ATLAS SHEET.

Orleans County.

Jeddo, copper plug in top of boulder, 3.3 feet high, in road corners, 50 feet from doorway of schoolhouse and 153 feet from doorway of Adventist Church, marked "U. S. G. S., B. M., 421"	418.838
Oak Orchard, iron bridge across Oak Orchard creek; copper bolt in abutment 6 feet from southwest corner, 1,000 feet east of postoffice, marked "U. S. G. S., B. M., 370 ft."	368.499
Eagle harbor, Gaines town, Erie canal bridge No. 131; copper plug in lower step, east wing, towpath side, marked "U. S. G. S., B. M., 516 ft."	514.559

Erie County.

East Clarence, 2,400 feet east of; copper plug in coping stone, east abutment at south end of bridge No. 114, Batavia and Tonawanda branch, New York Central and Hudson River Railroad, marked "U. S. G. S., 639 ft"	637.049

Transit, 700 feet west of railroad station; copper plug in west abutment next to lower step, south side of bridge No. 119, Batavia and Tonawanda branch, New York Central and Hudson River Railroad, marked "U. S. G. S., B. M., 587 ft" 587.533

Niagara County.

Pendleton Town; Erie canal guard lock bridge No. 168, copper plug in north end of east pier, marked "U. S. G. S., B. M., 582 ft" 579.818

Dysinger's Corners, Wm. Dysinger's red barn; crossmark in bronze tablet in southwest corner of foundation, marked "U. S. G. S. Elevation, B. M., 628 ft." ... 626.387

Gasport, Erie canal bridge No. 52; copper plug in east abutment, north end, marked "U. S. G. S., B. M., 521." 518.992

Lockport, Niagara county courthouse; crossmark of bronze tablet in front of, east of main door, Niagara street entrance, marked "U. S. G. S. Elevation, B. M., 616" 613.820

NIAGARA COUNTY, ORANGEPORT TO DYSINGER'S CORNERS.

McNall's Corners; square chisel mark southeast corner or doorstep of large brick house on northwest corner of road crossing 657.73

Dysinger's Corners; near house of Wm. Dysinger, rock at northeast corner of road crossing 622.47

NIAGARA COUNTY, LOCKPORT TO DYSINGER'S CORNERS.

Lockport, High street, opposite Beatty avenue; top of hydrant spindle 652.53

Lockport and Dysinger's Corners road, at bend to southeast 2 miles from Lockport; square chisel mark on westernmost of two boulders.....................	636.55
Dysinger's Corners, road corner 4 miles west of; square chisel mark on boulder opposite brick house near....	624.75
Dysinger's Corners, about 2 miles west of; top of large boulder north side of road near corner turning north, square chisel mark..............................	599.10

LOCKPORT AND OLCOTT SHEETS.

Niagara County.

Lockport north on Olcott road six and one-half miles to cemetery; thence east to Hess road; thence south to Ridge road; thence east to Hartland; thence south to Gasport.

Lockport; square chisel mark on stone monument at northwest corner of road intersection near Home of the Friendless..............................	491.54
Tollgate, 400 feet north of; square chisel mark on granite boulder 5 feet west of cycle path...............	487.10
Eighteen-Mile creek, square chisel mark on north abutment, west end of bridge........................	364.11
Wright's Corners, northeast corner of stone watering trough at town pump..........................	401.20
Wright's Corners, one and one-quarter miles north of on Olcott road; square chisel mark on flat rock south end of stone culvert over ditch, light yellow house on east side..................................	358.59
Cemetery, Pettit lot in southeast corner; in loop of capital "P" on lot monument, southeast corner.........	355.60

Checkered Tavern crossroads, one and one-half miles east of Ridge road; nail in old stump at southwest corner of road intersection...................... 409.27

North Hartland; road junction running north to; nail in stump northwest corner of roads............... 405.42

Hartland, three-quarters mile west of, north side of Ridge road; corner of second doorstep, west end of brick house.................................. 406.38

LOCKPORT ATLAS SHEET.

Hartland; square chisel mark on large boulder at southwest corner of road intersection.................. 404.55

Gasport, one and one-half miles north of; square chisel mark on large boulder nearly in front of large plaster-house on east side of road........................ 425.99

Gasport, canal benchmark on east abutment, towpath side of Erie canal bridge, marked with chiseled square 518.99

OLCOTT ATLAS SHEET.

Hartland, three-quarters mile north of, in front of W. T. Curtiss' house; copper bolt in granite boulder nearly embedded in ground in line of ditch, west, west side of road, marked "B. M., U. S. G. S., 376 ft.".... 373.920

Newfane town; copper bolt in granite boulder 30 feet southeast of District School No. 16, on road running east and west between Lake and Hess roads, about 3 miles north of Wright's Corners, marked "U. S. G. S., B. M., 363 ft."................................ 361.146

OLEAN SHEET.

The elevations in the following list are based on a bronzed tablet set in the foundation stones of the city building at Olean, which is marked "U. S. Geological Survey. Elevation 1,459 feet. B. M." The elevation of this benchmark above mean sea level is based on the top of rail in front of center of the Western New York and Pennsylvania railroad station in Olean. The best possible reduction of the profile of this railroad was made, resulting in an elevation at this point of 1,434.143 feet, and in accordance with this the height of the benchmark is 1,457.456 feet. The leveling was done by Messrs. E. L. McNair, levelman, and Farley Gannett, rodman, under the general direction of Mr. Frank Sutton, topographer.

Cattaraugus County.

Portville, Presbyterian church; copper plug in upper stone step at entrance, marked "U. S. G. S., B. M., 1,640 ft."	1,437.800
Ischua Town, Hinsdale-Ischua road; copper plug in large flat stone in base of stone wall under barn of Harris Johnson, south side of barn, west side of road, marked "U. S. G. S., B. M. 1,544 Ft."	1,541.918
Hinsdale, 1 1-2 miles south of Olean creek bridge, Faye Hollow highway; copper plug in capstone of bridge foundation, marked "U. S. G. S., B. M. 1,449 Ft."	1,447.639
Olean, City Building; cross mark on bronze tablet in foundation stone just beneath water table in northwest corner of building, Union street side, marked "U. S. Geological Survey, B. M. Elevation 1,459 feet"	1,457.458

OLEAN TO PORTVILLE.

Olean, W. N. Y. & P. R. R. Station, top of rail opposite.	1,434.14
Olean, Union street, near W. N. Y. & P. R. R. Station; highest point of rim of water plug embedded in rock in front of "Old Homestead" saloon	1,434.101
Olean, east end of Tompkins street, outer rim south side of eastern of two sewer traps in middle of street	1,430.87
Portville, road, nearly opposite tannery chimney spike in wooden post 2 feet high, south side of road	1,435.49
Haskell Creek Highway Bridge, near Westons Mills; top of coping stone east abutment, near southeast corner	1,431.45
Portville road, white house on south side of; northeast corner of horse block	1,439.13
Riverhurst Park; top of iron strap, northwest corner of watering trough, north side of road	1,440.72
Allegany river highway bridge west end of north abutment	1,438.71
Portville, one-half mile west of; southeast corner, stone horseblock north side of road	1,432.38
Portville, southeast corner of stone horseblock on north side of street, name Wheeler on front	1,439.90
Portville, W. N. Y. & P. R. R. station; top of rail opposite	1,442.07
Portville, Clarksville road; stone horseblock in front of Mr. Hutton's house, east side of street	1,439.55

OLEAN TO CUBA, VIA. HINSDALE.

Tannery, top of hydrant near entrance to backyard of..	1,433.69

Erie railroad, 150 feet north of; top of stone monument 9 inches square	1,437.54
Erie railroad crossing, three-quarters mile north of W. N. Y. & P. R. R.; top of outer rail of main track at curve	1,435.77
David Porter's house; northeast corner of upper stone doorstep	1,481.98
Erie railroad crossing, 2 miles north of; east side of center abutment of small railroad bridge	1,448.71
White house east side of road; stone horseblock in front of	1,442.92
Hinsdale, 1 mile south of; thread end of lower iron rod in west end of watering trough, on east side of road	1,465.79
Hinsdale, north end of; Oil creek bridge, post plate of iron post southeast corner of	1,458.50

HINSDALE TOWARD ISCHUA.

Scott corners; wooden horseblock in northeast corner of road intersection	1,471.13
Scott's corners, one-half mile north of; point in chiseled circle on corner of stone horseblock in front of white house on east side of road	1,499.26
Scott's corners, 1 mile north of, near Olean creek bridge; point in chiseled circle on boulder embedded in ground	1,498.21
Scott's corners, one and one-half miles north of; chiseled circle on point of large boulder at turn in road	1,499.93

ALLEGANY COUNTY.

Genesee town, Portville-Clarksville road near Obi, at Seventh Day Baptist Church; copper plug in large flat rock on west side of road 3 feet from fence, 10 feet from center of road and 85 feet from the church doors, on land belonging to Mrs. E. B. Adams, marked "U. S. G. S., 1547 Ft. B. M."...............	1,545.557
Clarksville, M. M. Congdon's residence; copper bolt in stone horseblock, marked "U. S. G. S., B. M. 1604 ft.".....................................	1,601.700
Cuba, Union street; bronze tablet in north end of the western of two piers of stone arch bridge, Erie railroad, marked "U. S. Geological Survey, Elevation 1524 Ft. B. M."..................................	1,522.410

PORTVILLE TO CLARKSVILLE.

Clarksville road, west side of; top of iron staple on wood hitching post in front of white house, dark green blinds and trimmings......................	1,515.04
Bedford's corner; top of boulder at corner of picket at northwest corner of intersection of roads........	1,493.26
Bedford corners, one and one-quarter miles northeast of, just above spring on northwest side of road; oblong boulder..............................	1,539.06
Bedford corners, 2 miles northeast of; stone horseblock in front of white house on southeast side of road...	1,548.64

Seven Day Baptist Church, first house south of on east side of road; highest corner of stone horseblock (house is two stories high, painted white and weather stained). 1,546.71

Cemetery, 750 feet northeast from; top of small boulder right hand side of bars at entrance to pasture, southeast side of road. 1,530.09

Obi, one-quarter mile south of; rock foundation at southeast corner of small wooden bridge. 1,520.59

Obi, 1 mile north of; boulder embedded in ground on east side of road, 100 feet south of bridge. 1,590.92

Clarksville, two-thirds mile south of; boulder inside fence of pasture near willow bushes. 1,561.55

CLARKSVILLE TO CUBA.

Clarksville, corner of stone horseblock on west side of street, marked "A. Cogden". 1,599.83

Clarksville, 2 miles north of; 750 feet west of signboard, chiseled point on top of boulder north side of road. . 1,684.13

Congdon's (M. M.), white house (green blinds), on southwest side of road; chiseled point of boulder almost embedded in ground nearly under wire fence in front of. 1,723.79

Compton's (Almon), house, east side of road; chiseled point on stone horseblock at side door. 1,852.69

Clarksville, two and two-thirds miles north of; chiseled point on top of very large flat boulder on west side of road, 85 feet south of watering trough. 1,947.43

Clarksville, road to right going toward; chiseled point on small boulder inside of bend at bend in said road. 1,988.29

Cuba, two and three-quarters miles south of; top of spike in block supporting south end of watering trough on west side of road opposite road from east,	1,748.37
Cuba, two miles south of; creek just below small bridge; rounded point of flat rock 2 feet above water surface.	1,637.82

Cattaraugus and Allegany Counties.

HINSDALE TO CUBA AND TOWARDS CLARKSVILLE.

Brown house, east side of road; chiseled point of boulder nearly imbedded in ground in front of..............	1,584.29
Hinsdale, 1 mile northeast of in unfenced meadow; top of boulder 30 feet east of road....................	1,558.60
Erie railroad stone culvert; chiseled point on fourth step from bottom...............................	1,481.24
Erie railroad stone culvert; chiseled circle around point on northwest corner of west end..................	1,516.23
Erie railroad track, 15 feet west of center of; point of boulder, chiseled................................	1,520.14
Cuba, 2 miles west of; large flat boulder at corner of road leading to Lake Cuba......................	1,507.60
Cuba, one and three-quarters miles west of; top of old rusty nail in west end of watering trough, north side of road	1,493.49
Cuba, A. J. Van Fleet's music store; boulder at corner of street in front of..............................	1,504.96
Cuba, water plug under Erie railroad stone arch bridge.	1,518.54
Wooden bridge, small; top of capstone of south abutment.......................................	1,551.17
Kuhn (Peter's) residence; point in chiseled circle on stone horseblock in front of......................	1,624.56

Cuba, one and one-half miles south of; rounded point of flat boulder embedded in ground near edge of creek just below bridge 1,637.62

ENGINEERING EXPENSES FOR THE FISCAL YEAR.

Ordinary Repairs Fund.

CANALS.

DIVISIONS.	Erie.	Champlain.	Oswego.	Black River.	Cayuga and Seneca.
Eastern	$8,817 17	$4,003 07	....	....	....
Middle	5,230 18	....	$574 09	$578 96	$607 6
Western............	9,974 62	....	....	....	....
	$24,022 97	$4,003 07	$574 09	$578 96	$607 6

Total $29,786 78

Special Appropriations.

Examination monuments and maps disbursed by division engineers, chapter 932, Laws of 1895, and chapter 950, Laws of 1896	$2,707
Examination monuments and maps paid directly by State Treasurer, chapter 932, Laws of 1895, and chapter 950, Laws of 1896	3,586
Upper Hudson river survey, chapter 599, Laws of 1895, and chapter 320, Laws of 1896	11,587
Geological survey, New York State, chapter 480, Laws of 1896	3,453
	$21,334

EXTRAORDINARY CANAL IMPROVEMENT.

Eastern Division.

provement Saranac river, chapter 169, Laws of 1894	$171 47
ake's draw-bridge, chapter 1009, Laws of 1895	80 55
ate bridge, Schenectady, chapter 462, Laws of 1895	67 05
pairs to Glens Falls feeder, chapter 284, Laws of 1895	697 85
all at Glens Falls feeder, chapter 286, Laws of 1895	824 36
metery culvert, Waterford, chapter 176, Laws of 1895	110 80
rman street bridge, Little Falls, chapter 680, Laws of 1895	199 55
ngthening locks 21 and 22, Erie canal, chapter 320, Laws of 1895	130 00
pairs to Rexford Flats dam, chapter 560, Laws of 1895	393 44
pairs, Smith's Basin, Champlain canal, chapter 298, Laws of 1895	106 06
Wall at Schuylerville, chapter 105, Laws of 1895	821 03
Dredging Albany basin, chapter 963, Laws of 1895	803 30
Improving Indian lake, chapter 104, Laws of 1895	70 50
State roads, St. Regis reservation, chapter 932, Laws of 1895	56 69
Sea Wall at Orient, chapter 838, Laws of 1895	228 77
Shinnecock and Peconic canal, chapter 932, Laws of 1895, and chapter 950, Laws of 1896	1,385 56
Shinnecock bay inlet, chapter 932, Laws of 1895	276 45

Cemetery culvert, Waterford, chapter 215, Laws of 1896	$119
Bullard's bridge, Champlain canal, chapter 254, Laws of 1896	201
Repairs to Steeles creek, chapter 365, Laws of 1896	403
Improvement, Erie canal, chapter 79, Laws of 1895, and chapter 794, Laws of 1896	56,971
Improvement, Champlain canal, chapter 79, Laws of 1895, and chapter 794, Laws of 1896	30,483
	$94,603

Special Surveys.

Making surveys and maps for the use of the State Board of Claims, chapter 932, Laws of 1895	$5,136

EXTRAORDINARY CANAL IMPROVEMENTS.

Middle Division.

Improvement Erie canal	$48,843
Repairs to Owasco lake outlet	1,720
Genesee street bridge at Utica	150
Vertical wall at Higginsville	227
Lift-bridge at Genesee street, Syracuse	999
Improving Cowaselon creek	2,249
Vertical wall at Clay street, Utica	186
Otisco lake inlet bridge	788
Cleaning Lake Brook ditch	90
Cleaning Manlius ditch	20
Cleaning ditch town of Elbridge	90
Gilbert street wall at Utica	495
Canaseraga creek culvert	170
Improving channel Butternut creek	96

..aning ditch at Port Byron	$120 00
..provement Oswego canal	15,559 58
..ne dam at Baldwinsville	397 22
..proving Oswego canal	16 40
..l apron to Braddock's dam	650 73
..ne apron to Oswego dam	235 54
..ver bridge at Carthage	1,857 77
..pairs to North Branch reservoir	2,741 47
..rvey on account of Attorney-General	316 63
..rden street bridge at Rome	605 46
..omas street bridge at Rome	592 00
..building locks Black River canal	2,161 92
..building lock 49, Black River canal	39 31
..pairs to highway at Cayuga	8 61
..otecting Cayuga and Seneca canal at Geneva	1,156 62
..proving Cayuga and Seneca canal, Seneca lake outlet	1,574 26
..proving Cayuga and Seneca canal at Seneca Falls	755 23
..proving Cayuga and Seneca canal at Waterloo	1,380 53
..ch between Seneca Falls and Waterloo	120 54
..pairing piers at head of Cayuga lake	46 94
..ridge survey foot Cayuga lake	467 71
..ighway town of Croghan	130 79
..ighway Onondaga Indian Reservation	68 34
..redging channel Lake Ontario to Wigwam cove	739 07
..iling outlet Lake Keuka	487 96
..iver bridge at Glendale	150 00
..xtraordinary repairs, Middle Division	1,868 70
	$97,369 05

Western Division.

Dredging Ohio basin, Buffalo	$864 0[illegible]
Dredging Seneca Lake level, Chemung canal	161 2[illegible]
Main street bridge, Fairport	1,023 2[illegible]
West Main street bridge, Rochester	60 00
Pendleton culvert	29 00
Mill street bridge, Buffalo	497 80
Tonawanda and Amherst ditches	1,000 00
Bridge at Falls creek, Montour Falls	205 65
Canal improvement	78,053 33
Glen creek, Watkins	427 14
Main street bridge, Newark	646 55
Dyke at Corning	490 37
Erie basin and docks, Buffalo	366 67
Repairing and improving Mud creek	834 93
Dredging Lower Black Rock harbor	616 26
Improving Catharine creek, Montour Falls	272 00
Exchange street bridge, Rochester	750 00
Bull creek improvement	583 80
Porter avenue bridge, Buffalo	2,706 59
Sewer at Horseheads	497 25
Repairs to Chemung canal at Horseheads	200 00
Divens ditch and culvert	160 02
Chemung river bridge abutments	126 80
Repairs to roads and bridges at Versailles	200 00
Repairs to highways at Redhouse	200 00
Repairs to bridge at Irving	200 00
Removing Porter avenue bridge to Jersey street, Buffalo	42 15

Scott street bridge, Buffalo	$218 97
Survey Newtown creek	1,276 62
Repairing highways from Lawtons to Versailles	93 77
Dredging and removing obstructions in Findley's lake	51 23
Genesee river storage survey	7,401 71
Ordinary repairs	9,974 62
	$110,231 95

Summary.

Ordinary repairs	$29,786 78
Extraordinary canal improvement	292,204 41
Special appropriations	26,470 44
Total engineering expenses	$348,461 63

FINAL ACCOUNTS PASSED IN THIS OFFICE DURING THE FISCAL YEAR ENDING SEPTEMBER 30, 1896.

Number.	CHARACTER OF WORK.	Name of contractor.	Engineer's estimate at contract prices.	Amount of final accounts.
1	Dredging Albany basin	P. W. Myers & Son	$9,513 00	$12,186 64
2	Renewal sidewalks State street bridge, Schenectady	Rochester Bridge and Iron Works	1,705 00	1,705 00
3	Iron bridge at High street, Cohoes, N. Y	Groton Bridge and Manufacturing Co.	3,722 00	3,699 50
4	Extending and rebuilding cemetery culvert, Waterford	Ira Parker	1,812 90	1,755 10
5	Repairs berme bank, Schuylerville	Cunningham & Monty	6,940 10	9,894 50
6	Wall at Glens Falls feeder, between Maple and Pearl	Wm. J. Dempsey	8,592 20	3,747 57
7	Rebuilding sea-wall at Orient	P. J. Brummelkamp	11,105 00	12,163 24
8	Shinnecock and Atlantic ocean	P. J. Brummelkamp	4,800 00	6,553 17
9	Drake's draw-bridge, Wappingers creek	Frank Pidgeon	3,628 00	3,616 71
10	Stone apron, Oswego dam	J. B. Donnelly	24,185 00	25,489 59
11	Bridge over Otisco lake	E. S. Candee	7,964 00	6,428 15
12	Culvert and vertical wall, second level, Cayuga and Seneca canal	Willard Johnson	8,230 50	9,704 05
13	Road over spillway, north branch reservoir	Michael Bennett	3,853 50	5,240 38
14	State ditch, Cowaselon swamp	E. G. Gay	21,850 00	27,596 25
15	Repairs Owasco lake outlet	J. J. Hallock	12,000 00	10,060 72
16	Opening channel. Wigwam cove	Jno. Hannan	10,000 00	8,541 90
17	Rebuilding locks 39-43, Black River canal	Dodge & MacGregor	38,881 50	37,963 24
18	Steel apron, Braddock's dam	Hughes Bros	16,475 00	15,024 14
19	Vertical wall, Turner and Gilbert streets	J. J. Dwyer	9,998 50	7,373 28
20	Vertical wall, Higginsville	Brayer, Albaugh, Lauer & Hagman	2,399 00	1,928 01
21	Vertical wall, Clay street, Utica	Brayer, Albaugh, Lauer & Hagman	2,499 50	2,019 37
22	Piling outlet. Lake Keuka	Brayer, Albaugh, Lauer & Hagman	8,414 00	6,655 99
23	Superstructure road and towpath bridge, Seneca Falls	Owego Bridge Co	1,550 00	1,550 00
24	Superstructure for Thomas street bridge, Rome, N. Y	King Bridge Co	2,500 00	1,980 00
25	Substructure for Thomas street bridge, Rome, N. Y	F. L. Faas & Co	3,496 00	3,518 00
26	Substructure for Garden street bridge at Rome	Brumelkamp & Lane	2,190 00	2,689 00
27	Dredging Ohio basin, Buffalo	Buffalo Dredging Co	36,328 00	47,125 00
28	Superstructure for Ohio street bridge, Buffalo	Wrought Iron Bridge Co	5,624 00	5,814 00
29	Superstructure for Emmerson bridge, Rochester	Wrought Iron Bridge Co	9,940 00	10,214 44
30	Substructure for Main street bridge, Fairport	Chambers & Casey	5,198 00	6,517 84
31	Superstructure for Main street bridge, Fairport	Rochester Bridge and Iron Works	7,795 00	7,796 00
32	Improvement Glen creek at Watkins	Brayer & Albaugh	3,139 60	4,236 11
33	Approach bridge at Mill street, Buffalo	Hilton Bridge Co	6,944 50	7,213 53
34	Docking and dredging in Erie basin, Buffalo	J. J. Churchyard	4,321 90	4,802 39
35	Brick sewer, Horseheads, N. Y	R. E. Beardsley & Co	[illegible]	[illegible]

[illegible]	Continuation of above contract	[illegible]	[illegible]	[illegible]
37	Iron bridge at Main street, Newark, N. Y.	Rochester Bridge and Iron Works	1,780 05	1,677 87
38	Ditching and iron culvert, Pendleton	Frank J. Le Valley	1,000 00	964 89
39	Improvement Catharine creek, Havana	W. S. Beckhorn	8,682 00	8,612 92
40	Improvement Mud creek, Lockport	W. T. O'Connor	8,470 00	8,808 25
41	Dredging Seneca lake level, Chemung canal	E. J. Hingston	5,848 00	5,740 15
42	Dyke on bank of Chemung river, Corning	R. E. Beardsley & Co	2,610 00	2,281 14
43	Dredging lower Black Rock harbor	Hingston & Woods	4,650 00	5,267 30
44	Improvement Bull creek	Dodge & MacGregor	1,018 00	1,785 55
45	Retaining wall, South St. Paul street, Rochester	Willard Fuller	8,298 90	3,208 74
46	Rebuilding Scott street abutment, Buffalo	Dodge & MacGregor		

TABLE OF CONTRACTS PENDING ON THE NEW YORK STATE CANALS ON THE 30TH DAY OF SEPTEMBER, 1896.

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Legislative. Chap.	Legislative. Year.	Appropriation.	Engineer's estimate.	Engineer's estimate at contract prices.	Payments to date.
Rochester B'dg & Iron Works	Nov. 16, 1895	German street bridge, Little Falls	680	1895	$8,000 00	$7,104 50	$7,445 40	$2,499 00
Chambers & Casey	Sept. 7, 1896	Lengthening locks Nos. 21 and 22	79 320	1895 1895	87,500 00	116,396 40	96,308 90	....
Cunningham & Monty	June 10, 1896	Bullard's farm bridge	254	1896	4,000 00	3,514 88	3,400 70	952 00
Michael Bennett	Sept. 26, 1896	Waterford culvert	364	1896	5,000 00	3,925 25	3,641 75	....
Jeremiah Adams	Oct. 11, 1896	Walls, etc., on the Glens Falls, between Glens Falls and Sandy Hill	286	1895	10,000 00	8,813 10	7,348 60	6,324 00
Jeremiah Adams	Sept. 10, 1896		796	1896	1,500 00	1,130 12	....	....
John J. Cunningham	Sept. 26, 1896	Rebuilding lock 9 (Becker's lock)	947	1896	....	27,142 80	27,447 00	....
P. J. Brummelkamp	....	Piling and protecting Shinnecock and Peconic canals	932 950	1895 1896	12,800 00 5,000 00	10,698 40 4,000 00	10,671 50 4,000 00	.... 10,819 00
James J. Dwyer	Aug. 18, 1896	Sea wall between East Marion and Orient	838	1895	....	....	....	....
James J. Dwyer	....	Sea wall between East Marion and Orient	950	1896	1,000 00	2,040 00	1,700 00	....
E. H. Fleming & Co.	Aug. 6, 1895	Protecting Cayuga and Seneca canal at Geneva	142	1895	15,000 00	1,500 00	10,948 00	8,075 00
G. W. Barlow	Aug. 30, 1895	Old Bear race, Waterloo	572 512	1894 1895	20,000 00	14,297 50	7,887 00	9,588 00
J. H. Nelson	Aug. 29, 1895	North branch reservoir	148	1895	25,000 00	17,983 50	16,764 00	12,410 00
E. H. Fleming & Co	Oct. 1, 1895	Improving Cayuga and Seneca canal and Seneca lake outlet	308	1895	20,000 00	13,600 00	10,041 00	6,460 00
Havana Bridge Works	April 21, 1896	Bridge at Garden street, Rome	965	1895	3,500 00	....	3,184 00	....
Dunfee, Belden, Dwyer & Co.	June 29, 1896	Bridge over Black river at Carthage	102	1895	....	5,135 00	4,704 00	3,672 00
Buffalo Bridge and Iron Works	July 2, 1896	Bridge over Black river at Carthage	102	1895	25,000 00	....	15,170 00	6,800 00
Brummelkamp & Lane	July 1, 1896	Bridge West Genesee street, Syracuse	311 950	1895 1896	12,500 00	10,655 00	9,865 00	....
Hilton Bridge Construction Co	July 3, 1896	Bridge West Genesee street, Syracuse	311 950	1895 1896	....	....	9,950 00	....
Havana Bridge Works	July 31, 1896	Bridge Genesee street, Utica	179 950	1895 1896	16,000 00 9,000 00	....	.... 13,187 40	....
Hughes Bros	Sept. 4, 1896	Bridge Otisco lake inlet	798	1896	10,000 00	8,912 00	8,318 00	2,431 00
Logie & Leh	Dec. 26, 1894	Bridge Porter avenue, Buffalo	668 482	1894 1896	10,000 00	1,000 00	946 25	....
Buffalo Dredging Co	May 8, 1896	Bridge Porter avenue, Buffalo, superstructure	590 482	1895 1896	62,500 00	25,556 00	19,497 75	10,880 00
Buffalo Bridge and Iron Works	May 9, 1896	Bridge Porter avenue, Buffalo, substructure	590 482	1895 1896				
Frank J. Le Valley	Aug. 29, 1896	Improving Mud creek	477	1896	15,000 00	12,672 00	8,810 00	595 00
White & Coughlin	Feb. 21, 1896	Bridge at Schuyler street, Havana	57	1895	5,000 00	4,932 50	3,972 00	2,295 00
Connelly Bros	Sept. 21, 1896	Buoys for Erie basin, Buffalo	521	1896	416 00	250 00	232 50	....

I desire to direct the attention of the Legislature to the reports hereto appended regarding the monuments marking the boundary lines of this State, all of which have been carefully looked after during the past year by Assistant Engineer C. H. Flanigan. Steps have been taken to replace such monuments as are missing and to repair such as have been injured or disturbed and a permanent record of all information pertaining to these monuments is now being compiled for facilitating future reference.

The annual reports of the several division engineers are also hereto appended and reference will be had to them for the detail of the greater portion of the work accomplished during the year and the cost thereof. This Department has also been charged with the engineering work connected with the enlargement of the quarantine station at Hoffman Island in New York harbor, and the report of Assistant Engineer John R. Kaley, which is hereto appended, will give the information pertaining to this important work in detail.

It is probably safe to say that the past year's work is the largest and most diversified of any ever accomplished by this Department, and to do this has required the faithful co-operation and support of every employee, for which my acknowledgment is justly due.

Respectfully submitted,

CAMPBELL W. ADAMS,

State Engineer and Surveyor.

APPENDIX I.

REPORT ON THE WATER SUPPLY OF THE WESTERN DIVISION OF THE ERIE CANAL.

By Geo. W. Rafter.

APPENDIX I.

ALBANY, N. Y., *April* 15, 1896.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Dear Sir.—As per instructions of February 1, 1896, I herewith present the following report on the water supply of the Western Division of the Erie canal with special reference to the deepening authorized by act, chapter 79, of the Laws of 1895.

The instructions also include making an investigation of the water supply of the Middle and Eastern Divisions, and of the Oswego and Champlain canals later on, and I have accordingly spent considerable time in examining the question of canal water supply in general, which would have been unnecessary if only the water supply of the Western Division required consideration.

At present the water supply of the Western Division is derived chiefly from Lake Erie, a small portion only being taken from the Tonawanda and Oak Orchard creeks, and from the Genesee river. Beginning at Commercial street, Buffalo, the distance to the east end of the division at the south line of Wayne county is 147.72 miles.

In discussing the water supply of the Western Division only such use will be made of the general information gathered as may apply to the study in hand, the presentation of the balance being reserved for a later report.

In their original estimates of a water supply for the Erie canal, the Canal Commissioners did not take into account, other than casually, the various losses to which artificial waterways are subject. The result was that a succession of dry seasons soon showed not only the insufficiency of the original estimates but the necessity of giving hydrologic questions more careful attention.

Still aside from some observations as to the losses from filtration and evaporation made by Messrs. Jervis and Bates in 1823 and 1824, it was not until 1835 that any serious attempt was made to gain accurate information as to the conditions in New York by long continued systematic observation. In that year John B. Jervis who was at that time chief engineer of the Chenango canal, began the gauging of the Eaton and Madison brooks. His results, while covering too short a period of time to furnish safe averages, have still been, as regards the yield of small drainage areas in this State, the handy stock in trade of the New York State Canal Department from that day to this. With the exception of the gauging of the flow of the Genesee river made for the last three years and those of the Hudson river and its tributaries began last year, they furnish the only extended data as to the yield of streams thus far gathered by the Canal Department.*

In 1838 Professor James H. Coffin, principal of the Ogdensburg Academy, made a series of evaporation experiments extending over that year. His results are as follows:

January, 1.625 inches; February, 0.817; March, 2.067; April, 1.625; May, 7.100; June, 6.745; July, 7.88; August, 5.415; September, 7.400; October, 3.948; November, 3.659, and December, 1.146 inches. Total for the year, 49.362 inches. These results were obtained by observing the variations in weight of a dish of water of the same size as the rain gauge, a method which undoubtedly gave results considerably in excess of the truth. Moreover a single year is too short a period for safe results, the same as in the case of the measurements of stream flow by Mr. Jervis.†

Gaugings of the loss from filtration and evaporation were made on the original Erie canal in 1824, by John B. Jervis on the Eastern Division and by David S. Bates on the Western Division. Mr. Jervis states that his measurements were made in the original Erie

---

*For Mr. Jervis' original report see Appendix F to An. Rept. Canal Com., 1835. Ass. Doc. No. 65, pp. 55-60. Mr. Jervis' tables, with extracts from the report, are also quoted in the following documents:

(1) Report of F. C. Mills, chief engineer Gen. Val. Can. in Appendix D to An. Rept. Can. Com., 1837. Ass. Doc. No. 80, p. 81.
(2) Report of W. H. Talcott, Res. Eng. Gen. Val. Can., 1840. Ass. Doc. No. 96, p. 51.
(3) Report of the Regents of the University, 1838, Sen. Doc. No. 52, pp. 208-11.
(4) Documentary History of the New York State Canals. By S. H. Sweet, Dep. State Eng. and Sur., 1863, Ass. Doc. No. 8, pp. 203-4.

† Professor Coffin's results may be found in the An. Report of the Regents of the University, 1838. Sen. Doc. No. 56, p. 222.

canal between the first locks below the village of Amsterdam and the aqueduct below Schenectady, a distance of 18 miles. The original Erie canal had the dimensions 40 feet water surface, bottom width 28 feet and depth 4 feet. The section where Mr. Jervis' measurements were made was mostly constructed through an alluvial soil, containing a large proportion of vegetable matter. In some places this soil was very leaky, owing, probably, to the decay of roots though the greater portion retained water very well. There was a considerable quantity of gravel and slaty soils.

Mr. Jervis stated that the quantity of water lost in this 18 mile section was very uniform and averaged 125 cubic feet per mile per minute.*

Mr. Bates stated that by measurements made in 1823 and 1824 he found that a mile of new canal, such as the Erie then was between Brockport and the Nine Mile creek, would require 100 cubic feet of water per mile per minute in order to supply the losses from filtration, leakage and evaporation.†

The following are some of the details of Mr. Bates' measurements in 1824:

On 79 miles of canal and feeder, comprising 20 miles of canal from Rochester to Brockport, 57 miles from Rochester to Cayuga and 2 miles of feeder, the supply was 8,000 cubic feet per minute, or 101.26 cubic feet per mile per minute. The months in which these observations were made is not stated although it may be inferred that they are averages of the canal season.

Mr. Bates also stated that in August, 1824, he found a total use for the 20 miles from Rochester to Brockport, of 2,100 cubic feet per minute, equal to 105 cubic feet per mile per minute. At that time the canal was in process of construction west of Rochester and the section from Rochester to Brockport was fed exclusively from the Genesee river. The measurements were, therefore, made by observing by means of floats the flow to the west through the aqueduct across the Genesee river.

This section of the old canal was considered to be entirely free

*Report of John B. Jervis, to the Canal Com. on the Chenango Canal, An. Rept. Canal Com., 1834. Ass. Doc. No. 55, p. 54.
† Report of David S. Bates to the Canal Commissioners on the Chenanago Canal, 1830. Ass. Doc. No. 47, p. 21.

from any leakage at the structures and the measured losses are therefore those due to percolation, absorption and evaporation.*

In August, 1839, Henry Tracy and S. Talcott, acting under instructions from W. H. Talcott, resident engineer of the fourth division of the Genesee Valley canal, made a series of observations along the line of the Chenango canal with a view of determining: (1) the evaporation and filtration; (2) the leakage at the mechanical structures, and (3) whatever else might be useful in designing the water supply of the summit level of the Genesee Valley canal.

For the purpose of the measurements they selected a portion of the canal extending from the north end of the summit level to the Erie canal and 22 miles in length, on which the supply on August 31, was found to be 2,343 cubic feet per minute. The leakage and waste at aqueducts, waste weirs and at lock No. 1 at the northern end was measured at 903 cubic feet per minute as the evaporation and filtration on 22 miles at 1,440 cubic feet per minute, equal to 65.48 cubic feet per mile per minute.†

It must be observed, however, that a measurement made at the end of August would not show a maximum of either evaporation or absorption by vegetation.

As stated in the foregoing, Messrs Tracy and Talcott also measured the leakage and waste at the various mechanical structures, etc. These amounted to: For leakage at structures, 220 cubic feet per minute; for waste at waste weirs, 204 cubic feet per minute; while lock No. 1 at the north end of the section gave a leakage of 479 cubic feet per minute. This amount Mr. Talcott remarks was so much greater than at any other lock on the canal as to induce the belief that the gates were not properly closed at the time of the measurement.

At lock No. 69, on the same canal the leakage was 382 cubic feet per minute for an 8 feet lift.

Mr. Talcott's report is a very able one and presents clearly all

* Report of F. C. Mills, in relation to the Gen. Val. Canal, 1840. Ass. Doc. No. 96, p. 26. Also, see report of W. H. Talcott, same document.
These two reports contain a summary of all that had been done in the way of measurements of the various losses now under discussion up to that time, as well as a number of references to the foreign data.

† Talcott's report, 1840. Ass. Doc. No. 96, pp. 42-43

the data at hand at that day. Without pursuing the matter further we may say that data which he gives fixes the following quantities as fairly covering the various losses to which artificial waterways of the dimensions of the original canals of the State are subject.*

(1) Loss by filtration, absorption and evaporation, 100 cubic feet per mile per minute. With retentive soils this could be reduced to from 60 to 70 cubic feet per mile per minute. Mr. Talcott fixed on 66 cubic feet per mile per minute for the Genesee Valley canal, but this was subsequently found too small.

(2) Leakage at mechanical structures; for locks of 11 feet lift, [illegible] cubic feet per minute; for leakage and waste at each waste weir, 30 cubic feet per minute; for a wooden trunk aqueduct an amount depending upon the length of the structure, as an average 35 of a cubic foot for each lineal foot of trunk.

In response to a resolution of the Canal Commissioners of date April 12, 1841, O. W. Childs, C. E., then chief engineer of the Erie canal, prepared a report on the water supply of the Western Division with reference to the enlargement then in progress.†

In this paper Mr. Childs gives the results of gaugings made in 1841 by himself of the losses from filtration, absorption, evaporation and leakage on the original Erie canal, between Wayneport, in Wayne county, and Pit lock, which corresponded to lock 53, near Clyde, of the present canal. He also gives the results of gaugings made by Alfred Barrett between Pittsford and Lockport.

Mr. Childs' measurements were for a section of the canal 36.02 miles in length. On the Palmyra level, for a distance of 8.34 miles, where the soil is open and porous, the gaugings showed a loss of 108.75 cubic feet per mile per minute. On the Clyde level with more retentive soil the loss of filtration, absorbtion and evaporation was, for a distance of 27.68 miles, only 35.26 cubic feet per mile per minute. The entire loss including the leakage was, for the whole distance, 84.05 cubic feet per mile per minute.

* The quantities apply to canals 28 feet by 40 feet, and 4 feet deep, and with locks 90 feet in length, 15 feet wide and about 8 to 10 feet lift.

† Paper relating to the supply of water required for the canal between Lockport and the Seneca river. An. Rept. Can. Com., 1848. Ass. Doc. No. 16, pp. 141-175.

These gaugings were made for a term of 33 days from July 30 t August 31, inclusive. Gaugings were also made in June, early i July and in the following October, from whence was derived th conclusion that the demands were greater and the supply less fo the time in which the observations were taken than during an other portion of the season.

Mr. Barrett's measurements were made at various points on th original canal between Pittsford and Lockport and repeated eac day from July 17 to September 30, inclusive. They showed an aver age loss for the whole period of 73 cubic feet per mile per minute Assuming the same ratio of loss between Pittsford and Wayneport and there resulted for the entire distance of 122 miles from Lock port to Pit lock, an average loss of 67 cubic feet per mile per minute

Mr. Childs states, however, that an addition to the foregoin quantity should be made as an allowance for springs and severa small streams entering the canal and which could not be gauged Making such additions, he concludes that 85 cubic feet per mil per minute should be taken as the total quantity consumed on th 122 miles of canal under consideration. This is equivalent to a total of 10,370 cubic feet per minute.

It is also stated that the supply of water was ample for all th purposes of navigation during the period covered by these gaugings

Comparing these measurements of 1841, with these made by Messrs. Jervis and Bates in 1824, and one point of great practica value at the present time is immediately brought out, namely, a to the excess of loss of water in new canals over those some tim in use. Let us examine as to just the difference on the Wester Division. Mr. Bates found a total loss of from 101.26 cubic fee per mile per minute to 105 cubic feet. In the absence of the detai we may assume that the springs and small streams allowed fo by Mr. Childs were delivering into the canal in 1824 the same a in 1841, at least 10 to 15 cubic feet per mile per minute. We hav then as the total supply in 1824 from 115 to 120 cubic feet per mil per minute. Adopting the latter figure as a maximum to compar with Mr. Childs' 85 cubic feet per mile per minute as found in

1841, and we conclude that the decrease in the loss by filtration due to the gradual silting up of the bottom was something like 35 cubic feet per mile per minute.

The application of this conclusion will be as to the increase in percolation from the present canal after the bottom has been disturbed, and in many cases slope walls rebuilt in the process of deepening. It seems clear that we must make the water supply liberal in order to fully answer the demands of the first few years while the bottom is again gradually attaining the fixed condition.

While on this question of liberal supply it may be remarked that the experience of about seventy-five years in the operation of the New York State canals has thoroughly shown the futility of any attempt at excessive economy in water supply. In the absence of systematic information as to yield of streams, the tendency has been to overrate the summer flow, with the result of shortage frequently at points where the supply was believed to be ample.

The chief sources of such shortage may be enumerated as:

(1) The great range in the yield of drainage areas from year to year by reason of variations in the rainfall and temperature.

(2) The result of clearing off forest has been to somewhat increase the spring flood flows and decrease the summer flow.

(3) The systematic drainage of large areas has also tended to increase the flood flows and decrease the summer flows.

(4) On long levels the growth of aquatic plants and the formation of sand bars in the canal itself have tended to decrease the amount passing.

Among minor sources of loss we may mention evaporation, which varies somewhat in different years; also absorption by growing plants. Neither of these, however, can be considered serious sources of loss.

A number of other gaugings of the loss from the original Erie canal are recorded in the reports, but the foregoing are sufficient for present purposes.*

A study of them in detail shows the necessity of providing for

* Ass. Doc., 1840, No. 96, p. 26. Also, Ass. Doc., 1842, No. 24, p. 37.

an artificial channel of the dimensions of the original Erie canal, and constructed on the American system, at least 80 to 100 cubic feet per mile per minute, exclusive of water for filling and for lockages.

By use of the data derived from the gaugings made in 1841, Mr. Childs arrived at the supply of the enlarged canal of that day in the following manner: It was assumed that the loss by filtration through the bottom and sides of the canal would be as the square root of the pressure or depth of the water* and as the area of the surface pressed. Proceeding on this line, he computed the quantity required to supply the losses from filtration, leakage and evaporation (in the enlarged canal of 1840—1860) at 190 cubic feet per mile per minute. This figure was subsequently substantially adopted for the entire enlarged canal, and with the exception of a few special cases is still in use to this day.

Adding the amount required for lockages at lock 53, and Mr. Childs placed the entire supply for the Western Division from Lockport to the east end at 208.59 cubic feet per mile per minute, or at a total of 25,448 cubic feet per minute for 122 miles of canal.

The most interesting portion of Mr. Childs' report is that relating to the dimensions of the long level from the foot of the locks at Lockport to lock 66 at Rochester. The problem may be stated in this form: Starting at Lockport, with a flow of 25,448 cubic feet per minute, it is required to find the dimensions of prism which will pass this quantity less 190 cubic feet per minute for every mile, and at the same time maintain a velocity not too great for convenient navigation. The minimum depth of canal to be 7 feet, and the mean velocity not to exceed one-half mile per hour.

With 25,448 cubic feet per minute supply at Lockport, the proper supply at Rochester was found to be 13,290 cubic feet per minute.

Several extended tabulations were submitted by Mr. Childs embodying different plans for the prism of the long level, but that which was finally adopted with some modifications is of more interest at present.

---

* In reality the loss should be proportional to the depth, because the discharge increases at the head.

Taking the formula

$$av + bv^2 = RI$$

in which

a and b are coefficients with the values

$a = 0.0000444499$, $b = 0.0000242651$.

v = mean velocity in linear feet per second,

R = mean hydraulic radius $= \frac{A}{P}$, and

I = inclination of surface $= \frac{h}{l}$ and applying it to a series of longitudinal sections about one mile in length it was found that with the following dimensions: Lockport, bottom width, 56.3 feet; water surface width 88.3 feet and depth 8 feet; Rochester bottom width 38 feet, surface width 70 feet, and depth 8 feet, and a velocity of not more than 0.733 feet per second, or one-half mile per hour, the delivery at Rochester would be 13,290 cubic feet per minute as assumed to be necessary for the supply of the balance of the division to the Seneca river.

This computation gave a total fall in the prism of 3.92 feet in the whole distance considered.

The foregoing is only a brief review of Mr. Childs' report and necessarily incomplete as to many of the details. The tables accompanying the report show the various plans which he proposed for the long level and may be readily referred to in the place cited. At present the report is of interest as showing the several steps taken in the design of the 62 mile level, which has, as finally constructed, a surface inclination of 3,165 feet in 62.49 miles.

The plans of the long level proposed by Mr. Childs, while interesting and valuable as indicating the broad lines of the final design, were still hardly satisfactory to the Canal Commissioners, chiefly because he proposed to take a supply at times from the Genesee river.

Previous to 1849 the draft on the Genesee river had been for a number of years very severe* and the Canal Commissioners were

*See report of the Select Committee on Memorial of Jacob Groves and others, occupants of the water of the Genesee river at Rochester, 1852, Ass. Doc. No. 102. Also, see report on the diversion of the water from the Genesee river, by Daniel Marsh, 1854, Ass. Doc. No. 63, pp. 146-160. A review of a large number of gaugings of the flow through the original Erie canal may be found in the appendices to Mr. Marsh's report. Also, see testimony and statements of L. L. Nichols, taken before the Canal Appraisers in 1855, in Sen. Doc., 1856, No. 108, pp. 111, 127, etc.

desirous, if possible, to feed the enlarged canal entirely from Lake Erie, or in case that were deemed impracticable to then furnish storage in compensation for the draft upon the Genesee river. In line with this view the Legislature had, by chapter 222 of the Laws of 1849, authorized the Canal Commissioners to convert Conesus, Honeoye, Canadice and Hemlock lakes, or any one of them into reservoirs for the supply of the canal.

In June, 1849, the Canal Commissioners employed Henry Tracy to make two investigations:

(1) As to the usefulness and policy of bringing Conesus, Honeoye, Canadice and Hemlock lakes into use as reservoirs as provided in chapter 222 of Laws of that year; and

(2) To examine and report upon the subject of a supply of water for the Erie canal from Buffalo to Montezuma, to be drawn from Tonawanda creek and Lake Erie.* In the beginning of his report on the usefulness and policy of bringing Conesus, Honeoye, Canadice and Hemlock lakes into use as reservoirs Mr. Tracy points out that it is necessary to determine, first of all, the amount of water required for feeding the enlarged canal between Buffalo and the Montezuma level, and reasoning from the data already cited he concludes that evaporation should be allowed for at the rate of 6 cubic feet per mile per minute while leakage, filtration and waste will use up 194 cubic feet per mile per minute substantially as computed by Mr. Childs. †

Mr. Tracy estimates lockage water for an average business of 200 lockages a day at 2,959 cubic feet per minute. For swelling descending boats out of the locks he estimates 740 cubic feet per minute, while leakage of the last lock is taken at 2,400 cubic feet per minute for a pair of double locks.

Mr. Tracy finally arrives at the following quantities as required to pass the different points, viz.:

---

* These reports are to be found in Sen. Doc., 1850, Nos. 40 and 41.

† Mr. Tracy's estimate of these various sources of loss of water is as follows:

Leakage	155.6 cubic feet per mile per minute.
Evaporation	6.1 cubic feet per mile per minute.
Waste	28.3 cubic feet per mile per minute.
Contingencies	10.0 cubic feet per mile per minute.
Total	200.0 cubic feet per mile per minute.

Black Rock, 35,020 cubic feet per minute.
Tonawanda, 31,240 cubic feet per minute.
Pendleton, 31,000, cubic feet per minute.
Middleport, 27,200 cubic feet per minute.
Albion, 24,000 cubic feet per minute.
Brockport, 21,000 cubic feet per minute.
Rochester, 17,000 cubic feet per minute.
Lock 53, 6,100 cubic feet per minute.

Experience for the last 35 years has shown that these quantities ile apparently large are not greatly in excess of the actual re-irements. Indeed due to the large use of water power at Black ck and Lockport, they have at times been even somewhat in-ficient.

In his report on the proper size, plan and surface inclination for Erie canal enlargement between the Tonawanda creek and ntezuma, Mr. Tracy determines and fixes the proper area of ss-section, depth of channel and slope of surface required to s the quantities of water proposed in the preceding, in order at the mean velocity of flow may not exceed one-half mile per ur, or 0.733 linear feet per second.

At that time the down tonnage was about five times as great the up tonnage, hence it was concluded that a slight current oring the descending trade would do no injury but be rather a efit.

To compute the flow Mr. Tracy used the Prony formula.

$$v=\frac{1}{2b}\left(\sqrt{4b\,ID+a^2}-a\right)$$

which,

v = the mean velocity in cubic feet per second.

I = the inclination, and

D = the mean hydraulic radius $=\frac{A}{P}$

For values of a and b he used those of Prony, in which a=0.000-44499 and b=0.0000942772 for determining the flow with full nal; and for low water those of Eytelwein, in which a=0.0000-2651 and b=0.0001114155. At the velocity of 0.733 linear feet r second, the constants of Prony give results differing about 5 cent. from those of Eytelwein.

In a special report to the Senate made under date of February 28, 1849, the Canal Commissioners state they have fixed the general dimensions of the enlarged canal at 7 feet depth; width at water surface, 70 feet; bottom width 52.5 feet, with slope wall at sides one and one-quarter to one.*

It was apparent, however, that the prism of the long level must mostly be considerably larger than this in order to carry the required quantity and not exceed the velocity of 0.733 linear feet per second. This section gives an area of 428.75 square feet. Hence, the standard section could be maintained on the long level as far west as this section would pass the computed quantity with a mean velocity not exceeding 0.733 linear feet per second. This point was found to be 9 miles west of Rochester. From there to Tonawanda creek the prism would necessarily be in excess of the general section.

For the western portion of the long level Mr. Tracy submitted four plans embodying various widths at water surface and on the bottom, as well as varying depths. It is unnecessary to review these several plans in detail as they may be found in Mr. Tracy's report at the place cited. They all involve varying depths and slopes at time of high water different from those at low water; even at low water the surface slope varies from 3.41 to 4.30 feet, while at high water Mr. Tracy's different plans propose surface slopes ranging from 6.2 to 7.3 feet. It appears to have been overlooked that surface slopes of this extent would have involved a uniformity of feeding rather difficult of attainment. Basing the resulting flow, however, on the formula used it is clear that the extreme slopes proposed by Mr. Tracy were imperative, with the assumed cross-sections, if it were proposed to feed entirely from Lake Erie and absolutely without reference to the Genesee river. In this connection it may be again pointed out that Mr. Childs' proposed slopes, which, involved feeding from the Genesee river, were much less than Mr. Tracy's, and since it was Mr. Childs' plan, modified somewhat as to slope and dimensions of prism that was finally carried out we are forced to the conclusion that the Canal

* Sen. Doc., 1849, No. 50, p. 2.

'ommissioners finally adopted the fixed policy of feeding the east nd of the Western Division, so far as necessary, from the Genesee iver.

I have pursued this matter of the indications of the original eports somewhat at greater length than would otherwise be done, because, in order to keep the velocity of flow within or near the proper limit, it appears necessary, in designing the water supply of the present enlargement, that we take an additional quantity of water from the Genesee river. In view, therefore, of the controversies which have existed for 75 years between the owners of the water rights on that stream and the canal authorities it is desirable to fully understand that a suggestion of taking additional water from the Genesee is fairly in line with the policy of the Canal Board for the last 45 years.

In leaving the discussion of those early reports on the water supply of the Western Division I wish to record my admiration of the manner in which the subject was treated by Messrs. Childs and Tracy. Both were skillful engineers and when we take into account that aside from the original Erie canal there was no precedent for a canal level 62.5 miles in length with a surface descent for the whole distance, one can not but accord them sincere praise for their comprehensive reports.*

The matter of just the dimensions to be given to the prism of the enlarged canal between Lockport and Rochester remained, however, in abeyance until 1854 in which year the dimensions as they

---

* Mr. Childs' report is especially interesting to the cultivated hydraulician not only because of the magnitude of the problem but because of the manner of treatment. Mr. Childs' plan No. 2, wherein he applies the differential problem

$$ds = \left(\frac{w - \frac{v^2 s}{g}}{z\,(av + bv^2)} \right) dh$$

is of value as being, so far as the American literature of canals is concerned, the only case in which the higher mathematics had been applied to the solution of this problem at that time. In this equation we have:

w = area of the section.
v = velocity.
s = width at water surface.
z = wetted perimeter.
g = acceleration of gravity.
h = depth.

and ds a differential quantity to be integrated between the limits h = 8 and hm = the depth at Lockport.

Those interested in the application of differential equation to such problems are al[illegible] referred to a paper on the "Flow of Water Through Level Canals," by James Atkins Longbridge, M. Inst. C. E. in Proc. Inst. C. E., vol. LIII, (Ses. 1877-78, pt. III), pp. 216-2[illegible]

now exist were finally fixed, but not until thoroughly discussed at several meetings of the Canal Board.

At a meeting on September 16, 1850, the following was offered " Resolved that the enlargement of the Erie canal through the villages of Brockport, Albion and Medina, to the extent represented and described by the surveys, maps, plans and specifications this day presented by the State Engineer and Surveyor be and the same are hereby ordered to be constructed of the dimensions required by the following description of the size of the canal and upon the line described in the following resolution to wit:

"At the lowest lock at Lockport the mean width of the water way of said canal shall be 91 feet, and the depth of the same 9 feet, and from thence the water channel of said canal shall regularly diminish (except where a saving of expense will warrant a wider channel), to mean width of 62 feet and 9 feet depth of water at the point where the enlarged canal in the city of Rochester is 62 feet in mean width, thence to the Rochester aqueduct to have a mean width and depth of 9 feet water, and thence to the easterly end of said aqueduct as the same now is, and thence to the first lock east of Rochester said canal to have mean width of water way of 60 feet and a depth of 8 feet."*

At the meeting of the Canal Board, June 6, 1854, John T. Clarke, State Engineer and Surveyor, submitted a report on the long level in which, after reviewing the report of Mr. Childs, he offered a resolution that the enlarged canal between Lockport and Rochester be constructed in conformity to the following dimensions:

" The bottom of the canal at Lockport to be located 18 inches below the top of the mitre sill of the lowest lock at Lockport, and descending two feet to a uniform declivity to the bottom of the Rochester aqueduct, the prism to be so constructed as to admit of 7 1-2 feet of water above the top of the said mitre sill at Lockport and 7 1-3 feet above the bottom of the Rochester aqueduct with a bottom width throughout of 52 1-2 feet, and a surface width at Lockport of 75 feet and at the west end of the Rochester aqueduct of

* Manuscript proceedings of Canal Board, vol. D, p. 328. Also, see table in An. Rept. State Engineer, 1877, p. 214.

83 feet, giving a surface declivity in the whole distance of 3 2-3 et. The prism, from Lockport to Rochester, to diminish uni- rmly in size, etc."*

This resolution was also subject to considerable discussion until ally the following dimensions were substantially fixed upon and nbodied in plans submitted by the State Engineer and Surveyor on eptember 12, 1854.†

At Lyell street, Rochester, bottom width, 55 feet; surface width, 5; depth, 7.8 feet. Lockport, bottom width, 79 feet; surface idth, 100 feet; depth, 8 feet.

West of Lockport the dimensions had been fixed several years efore substantially as proposed by Mr. Tracy, as follows: ‡

Through the rock cut for two and one-half miles west of Lockport, th bottom and water surface width, 62.5 feet; depth, 9.5 feet. rom the west end of rock cut to Pendleton, bottom width, 96 feet; ater surface, 100 feet, and depth, 9 feet.

From Pendleton to Tonawanda the Tonawanda creek affords an ficient navigation with dimensions generally in excess of the re- uirements of the canal.

From Tonawanda to Black Rock guard lock, bottom width, 72 et; surface width, 90 feet, and depth, 9 feet.

From Black Rock guard lock to the connection with Lake Erie was considered that the great width of the Black Rock harbor ould furnish at all times a sufficient amount of water.

During the years while the construction of the long level was in rogress there was a tendency for the water to accumulate at the ast end, while it was slack at the west end. For a number of ears, however, this tendency has not been specially observed.§

* Manuscript proceedings of Canal Board, vol. 10, Canal Enlargement, pp. 46-52. Also, ble in An. Rept. State Engineer, 1877, p. 214.

† It is stated that these dimensions were substantially fixed upon at that time, al- ough a few changes have been made since 1854. For instance, the original depth at ochester was 7 feet 4 inches, which made the canal bottom 2 inches below the bottom the aqueduct at the west end of same. Chapter 399 of the Laws of 1874, authorized the wering of the bottom of the aqueduct 6 inches and the deepening of the canal 6 inches ow the established grade from the aqueduct to the wide waters west of Rochester. As gards the water surface of the long level no change has been made since it was orig- ally fixed in 1854. Also, see Report State Engineer, 1877, p. 212.

‡ Although Mr. Tracy's general plan has been followed, so far as can be learned, the ly resolutions of the Canal Board establishing grades of this portion of the canal are se of September 22, 1849, and September 7, 1850, which provide for a top water line 100 et in width between Tonawanda creek and Sulphur Spring guard lock and 90 feet in idth from thence to the rock cut with a depth of 8 feet in each case. As regards formal tion of the board, the matter seems to have been left indefinite.

§ Annual Report of the State Engineer and Surveyor, for the year ending December 31, , p. 63, where a statement of the dimensions of the long level as fixed in 1854 may be und.

In the summer of 1876 W. H. Searles, M. Am. Soc. C. E., Division Engineer of the Western Division, working under the authority of Chapter 425, section 6, of the Laws of 1876, made a survey of the Western Division in which levels and cross-sections were carefully taken and which furnishes a large amount of information as to the actual working of the long level.

In computing the water supply of the long level Mr. Searles used the formula:

$$f = p\left(\frac{(v + 6.534)^2}{6119 + 0.6A}\right)$$

in which

f = fall of surface in feet per mile

p = wet perimeter in feet

v = mean velocity in feet per minute $= \frac{D}{A}$

D = discharge in cubic feet per minute and

A = sectional area in square feet.

Applying this formula to the conditions actually existing in 1876 it was found that the original assumption of from 190 to 200 cubic feet per mile per minute as supplying the losses from evaporation and filtration was fairly sufficient. Mr. Searles' study may be taken as establishing these figures for a canal of the dimensions of the Erie canal on the Western Division and for such meteorological conditions as prevailed in 1876.*

Mr. Searles' results are given in such detail in his report as to render extended citation unnecessary and we may merely refer to the following quantities of water which he found at several points on the level:

Lockport	33,755 cu. ft. per minute
Middleport	28,100 cu. ft. per minute
Holley	19,024 cu. ft. per minute
Rochester†	12,175 cu. ft. per minute

* For Mr. Searles' results in detail see (1) An. Rept. State Engineer for year ending September 30, 1876, pp. 166-170; (2) An. Rept. for year ending September 30, 1877, pp. 206-225; and (3) a paper, "Description of Survey for Determining the Slope of Water Surface in the Erie Canal," Trans. Am. Soc. C. E., vol. VI (January to December, 1877), pp. 289-393.

† From table in Trans. Am. Soc. C. E., vol. VI, p. 293. With only 12,175 cubic feet per minute supply at Rochester it is probable that a considerable quantity was being taken from the Genesee river.

BUFFALO SEWAGE IN THE ERIE CANAL.

Ever since the beginning of the rapid growth of the city of Buffalo iere has been more or less controversy between the municipal and ate officials as to the inflow of the sewage of the city into the inal. On the one hand the large amount of deposited sludge om the house drainage as well as the mud from the street washgs has been a serious detriment to the canal as well as the source considerable expense for dredging from year to year. On the her hand the Buffalo municipal authorities have claimed that the tate by the construction of the Erie canal along the water front id cut off the natural line of drainage of a large portion of the city id that as a matter of equity the State ought not to complain on count of the expense of dredging caused thereby. The growth of he manufacturing interests and the consequent discharge of vast nantities of manufacturing wastes as well as an increased amount f house sewage finally led to the construction, about 13 years ago, f a main trunk sewer which intercepted and discharged into the iagara river near Ferry street, the greater part of the dry weather ow of the sewage which formerly polluted and caused deposits the Erie canal. Later another main drainage system has been nstructed to the north of that of 13 years ago.

In order to show the relation of these intercepting sewers to the Erie canal I have prepared a map of the Buffalo water front with ie lines of sewers and sizes of same laid down thereon as per Plate . From Bird avenue on the north to Swan street the dry weather low of all sewers is intercepted and carried under the canal into ie Niagara river near Ferry street; between Bird and Hertel avenues there is a small district still tributary to the canal as indicated n Plate I., while to the north of Hertel avenue there is another nain drainage system which carries dry weather sewage under the anal near Arthur street.

Both of the foregoing main drainage systems have numerous torm overflows into the old sewers leading directly into the canal, hrough which considerable quantities of storm water is discharged it every rain storm. One of these at Bird avenue is 4.67 x 15.0 feet. The Scajauquada creek also empties into the canal near Wayne

street, but most of its flow has been taken through a State ditch into Cornelius creek, which passes under the canal near Ontario street.

South of Swan street the entire sewage of a thickly populated and important manufacturing district is still tributary to either the Hamburgh canal, the Ohio basin, or some of the intermediate slips and connecting lateral canals, or to the Buffalo river.

From general data furnished by E. B. Guthrie, M. Am. Soc. C. E., deputy city engineer, it is estimated that at present time the sewage of about 22,000 people living in the 1st, 2d, 3d, and 4th wards is tributary to the Erie canal and its lateral connections. This includes the district tributary to the Hamburgh canal. To the south of this district it is estimated that the sewage of 23,000 persons passes into the Buffalo river and from thence a portion of it finds its way through the Niagara, Erie and Peacock slips into the Erie canal, while another portion hugging close along the shore flows into the head of the Black Rock harbor and so finally into the Erie canal through the openings in the harbor division wall below Ferry street.

In the district between Bird and Hertel avenues it is estimated that a population of 2,000 now contributes sewage to the canal.

The new constitution of 1895 provides for the abandonment of the Hamburgh canal by the State; and when this is done and the matter of filling this canal taken in hand, as it probably soon will be, a considerable decrease in the pollution will result from the works which it will then be necessary for the city of Buffalo to construct in order to take care of the sewage now tributary to the Hamburgh canal. So far as the present is concerned, however, we may discuss the question as though that pollution was a permanent one, as the vast growth of Buffalo is every year tending to more serious pollution from this source. We may say then that we have at the present time the sewage of $22,000 + 2,000 = 24,000$ people directly tributary to the canal at Buffalo and 23,000 indirectly tributary; probably we may say that of this latter number the sewage of about one-half, or 12,000 people, reaches the canal.

The storm overflows also contribute sewage equivalent to a con-
·nt flow from say 25,000 people. This is of course a general
·imate based upon a partial study of the size of the sewers in
·ation to the area and imperviousness of the territory drained
·m which it has been concluded that some of the overflows must
·me into service very quickly, and while, in the case of sudden
·rms, the first washings of the streets and the scourings of the
·wers themselves are still flowing. This portion of the estimate
· however, subject to modification when more data shall be ob-
·ned. In the meantime, taking into account that the total
·butary population is over 250,000, an estimate that one-tenth
· the sewage is discharged by the storm overflows can not be
·nsidered specially unreasonable.

We may take them for purposes of the present general dis-
·ssion a total equivalent population contributing sewage to the
·e canal at Buffalo of 24,000 + 12,000 + 25,000 = 61,000. As-
·ming a dilution of 500 cubic feet of water per minute per 1,000
·ntributing population, we may conclude that with a total water
·pply of from 50,000 to 60,000 cubic feet per minute there is no
·bability of this amount of sewage causing an effluvium nuisance,
·d our inquiry is accordingly limited to the effect of the actual
·antity of sewage in forming sewage mud deposits which neces-
·rily must be removed by dredging, at considerable expense, from
·ar to year.

Referring to the general data of sewage, sewage muds, etc., as
·ven by Rafter and Baker,* it is learned that the chief polluting
·gredients of sewage are human excrements, kitchen wastes,
·reet washing and refuse of various manufacturing processes.
· a large manufacturing city like Buffalo we may place the solid
·atter which is likely to be deposited as sewage mud at about 7
·bic feet per capita per year, or at one-fourth of a cubic yard.
This includes the street washings, which at times carry large
·antities of mineral matter from the street surfaces.† We may

* Sewage Disposal in the United States, chapter V, VII, etc.

† On this point see paper on Sewage Treatment and Sewage Disposal, by W. Sante ·mp. Eng. and Bldg. Rec., vol. XXVII, p. 237 (Feb. 18, 1893). Also, Sewage Disposal in ·e United States, p. 154.

have, then, on this basis, about 15,000 cubic yards of mud per year deposited in the canal from the city sewage. Aside from a small amount of sewage received at Lockport, Medina, Holley, etc., this is the only really extensive source of mud deposits in the canal on the Western Division.

By way of illustrating the effect of this amount of sewage mud annually in obstructing the canal prism, it may be pointed out that 15,000 cubic yards if deposited uniformly would make about one-half an inch in depth over the first 30 miles of the canal to the east of Buffalo. This figure takes into account the extra width of the Tonawanda creek for several miles between Tonawanda and Pendleton.

The great width of the Tonawanda creek between Tonawanda and Pendleton, however, affords a modifying element which makes the effect of the present inflow of Buffalo sewage considerably less serious than it would otherwise be.

The velocity of flow in the canal between Buffalo and Tonawanda is rapid enough that a considerable portion of the suspended matter is carried into the Tonawanda creek, where, with the material decrease in velocity which ensues in the wide creek channel, the most of the deposits take place.

Again, this creek is subject to heavy flood flows toward the Niagara river, at which times the sewage mud deposits are swept out into that stream. The substituting of a movable dam in place of the present fixed dam at Tonawanda as discussed on page 198 would assist greatly in making the scouring out of the Tonawanda creek more thorough. Generally, however, the Tonawanda creek channel maintains itself under present conditions.

As a final conclusion, in regard to Buffalo sewage, it may be stated that, aside from a few thousand cubic yards of deposits, annually, in the Ohio basin and connecting slips and lateral canals, it is not a serious factor in maintaining the proper depth of channel necessary to insure a full water supply from Lake Erie at the present time.

The sanitary side of the question, either as to the effect on health of people living along the line of the canal or on those navigating

it, is not taken into account in the present discussion. More extended study would be necessary before any useful conclusion could be arrived at on this point. As indicated on page 191, the degree of dilution is ample to insure freedom from serious effluvium nuisance.

WATER POWER ON THE WESTERN DIVISION.

When the Erie canal was first constructed the Legislature adopted the policy of leasing the so-called surplus water for power purposes wherever they might exist along its line. In pursuance of this policy, "An act concerning the Erie and Champlain canals," as passed in 1825, provided that the Canal Commissioners should sell at public auction the right to use the surplus waters wherever, in their opinion, such waters could be spared without detriment to navigation or security of canal. Under the terms of this act leases were executed to a number of persons at Black Rock in 1827, and the following years, and in 1826, to Richard H. Kennedy and Junius H. Hatch at Lockport. Even as late as 1851 the surplus waters at Arcada, in Wayne county, were leased to Roderick Price by virtue of an act passed April 12, 1848.

So far as known to the present writer the leases at Black Rock, Lockport and Arcadia, include all made on the Western Division.*

In the original construction of the Erie canal it was designed to secure a full supply of water from Lake Erie as far east as Montezuma. An error in levels, however, by which the canal was made level from Brockport to Rochester, instead of descending uniformly as intended from Lockport to Rochester, rendered the permanent carrying out of this intention in the original canal impossible. In the enlargement this error was rectified and the water surface given a uniform slope of a little over three feet from the foot of the locks at Lockport to lock 66, in the eastern part of the city of Rochester. In fixing the dimensions of the long level from Lockport to Rochester, it is clear from the information given on the preceding

* For full text of these leases see Report of the Special Committee appointed to examine the leases and uses of the surplus waters of the State canals, Ass. Doc. No. 139, 1870, pp. 28-63. This report contains a full account of all the leases granted under the act of 1825 and subsequent acts, as well as an able presentation of the various economic questions raised by the granting of these leases.

pages that the Canal Commissioners really intended to supply the enlarged canal with water from Lake Erie to Montezuma without resort to the Genesee river. There are, however, three modifying circumstances (1) the plan of Mr. Childs, which was, with some increase of cross-section, substantially adopted, does not admit of passing easily the required quantity to the east of Rochester if the prism is at all obstructed by the growth of aquatic plants or the formation of mud deposits; (2) the plan of Mr. Childs which involved feeding at times from the Genesee river was the only one that could be adopted because the two ends were, in effect, fixed by the construction of the locks at Lockport and the Genesee aqueduct at Rochester previous to the enlargement of 1860; and (3) the large development of water power at Black Rock and Lockport introduced new elements into the problem which, so far as the record shows, was either only casually considered or not at all. It has resulted, therefore, that more or less water has been taken from the Genesee river for nearly every year since the enlargement was completed.

The water power at Black Rock is created by the difference in level between the water in the canal and harbor, and that in the Niagara river outside the harbor wall.

According to a map made by Peter Emslie, C. E., entitled "A map of Buffalo and Black Rock harbor," and on file in the office of the division engineer at Rochester, the difference of water level between the harbor and river is:

At head of Squaw island, 4.12 feet.

At the Ship lock, 5.16 feet.

Mr. William H. Wentworth, a millwright of large experience in the Black Rock mills, states, however, that the average difference of elevation varies from about 4.0 feet at the head of Squaw island to about 4.5 feet at or just below the Ship lock. At the present time it is about 4 feet. In any case the head was small and the use of water for the production of any considerable power necessarily large.

It is learned from the report of the Assembly committee of 1870,*

* Ass. Doc., 1870, No. 139.

that there were formerly 10 mills in operation here using 164,680 cubic feet of water per minute. Mr. Wentworth estimates the actual power developed by these mills when all operating at full capacity at not more than 520 horse power. The water wheels were of the reaction pattern and probably gave not more than 40 to 50 per cent. efficiency. It we allow then 50 per cent., the use of water when all were running must have been about 130,000 cubic feet per minute. Adding something for the leakage which at the mills still in existence is very large, and there must have been a loss of water at Black Rock due to the leased water power of from 150,000 to 160,000 cubic feet per minute. The Assembly committee in their report of 1870 place it at 164,680 cubic feet per minute. Inasmuch as the mills were all in existence at that time and the committee's opportunities for accurate estimates, therefore, superior to mine, we may accept the estimate of 164,680 cubic feet per minute as right.*

Owing to the decline of the milling business in New York State a number of these mills have passed out of existence until, in 1896, the Frontier, Clinton, Queens City and Marine are the only ones left. None of these are in use at the present time. The Clinton mill has been changed into an elevator and may run during a portion of each summer. The Frontier and Queen City have been out of service for the past two years, except that the Queen City ran a short time in the summer of 1895. The Marine has run more or less during the past, but is standing idle at present.

* The following are the original mills at Black Rock, with number of runs of stone, number of wheels and power developed as estimated by Mr. Wentworth.

Name of mill.	Runs of stone.	Number of wheels.	Est. horse power.
Frontier	7	9	93
Clinton	5	8	64
Queen City	7	9	90
Gibsons	2	2	16
Marine (Erie)	7	7	84
Niagara	9	5	70
Globe	3	2	24
North Buffalo	9	4	56
Starch factory	3	3	25
Parmelee's sawmill	..	2	18
Total	52	51	520

The water wheels were all of the same pattern but varied in size.

The four mills still in existence here require about 70,000 cubic feet of water to operate them at the full capacity of the wheels now in place.

The use of water by the Black Rock mills has always been a detriment to the navigation. When all running, the amount of water actually drawn through the canal and harbor for their supply and for the supply of the canal to the east of Buffalo was fully 200,000 cubic feet per minute.*

In addition there is now and has always been more or less leakage through the river wall of the harbor, which it is impossible to estimate under the existing conditions with any accuracy but which may be placed generally at perhaps 10,000 cubic feet per minute.

While all the Black Rock mills were in operation, the great draft of water so obstructed the navigation that the Legislature finally authorized the construction of a division wall in the harbor whereby it was expected that the water supply for the mills would be entirely taken from the harbor, leaving the channel of the canal proper entirely free for the purposes of navigation; but after the major part of the wall was completed it was ascertained that because of the silting up of the upper harbor with sewage mud as well as drifting sand from the lake, there would be difficulty in obtaining a full supply for the mills through the harbor without expensive dredging. For some reason the division wall was never completed, two gaps, amounting in the aggregate to several hundred feet having been left below Ferry street; and we have here, therefore, the case of an expenditure for the benefit of the milling interests of a number of hundred thousand dollars, which is entirely without effect for lack of entire completion.†

* The Assembly committee of 1870 give the following figures as applying at that time:

Lower Black Rock mills	113,200 cubic feet per minute.
Upper Black Rock mills	51,480 cubic feet per minute.
For supply of canal	35,000 cubic feet per minute.
Total	199,680 cubic feet per minute.

† The division wall, in its present condition, cost about $350,000. For information in regard to reasons for building the harbor division wall see An. Rept. of State Engineer and Surveyor, 1862-1863. Also, report of W. H. Searles, Division Engineer, in An. Rept. State Engineer for 1876, p. 166.

The decline of these interests may probably be taken as the reason for leaving the division wall incompleted.

In the report of 1870, the Assembly committee suggest three remedies for the troubles to navigation at Black Rock:

(1) To abrogate the leases.

(2) To complete the division wall between the canal and harbor. On this point the committee suggest that the completion of the division wall would obviate nearly all the difficulties to navigation which then existed at that point. If communication between the canal and harbor appears desirable for the benefit of navigation, such communication should be obtained by means of gates to be opened only when boats require to pass from the canal to the harbor, or the contrary. The draft for the mills through the harbor would also tend to keep a channel there clear of deposit, thereby avoiding the necessary expense of dredging in the harbor.

(3) As a third remedy the committee propose to enlarge and deepen the canal from Tonawanda to Lockport, at the same time removing the Tonawanda dam, which is about 4.5 feet in height, and draw the main supply of water from the Niagara river at Tonawanda, instead of Buffalo, as at present.

As regards these three remedies it may be said that the decline of the mills has mostly settled the first, and also rendered the second less important than 26 years ago. If, however, the remaining mills are to operate to any large degree in the future, then the division wall should be completed on the original plan. As to the third head there are other reasons why either the proposed deepening from Tonawanda to Lockport may be still beneficially carried out, or if such deepening is too expensive, an alternative proposition may be considered, which we will now briefly discuss.

Between Tonawanda and Pendleton there are large areas of productive flat lands which are subject to frequent and serious overflow from the Tonawanda creek.* The removal of the dam and the considerable deepening proposed by the committee would provide an effectual remedy for this difficulty.

* The floods were especially serious here on March 31, 1896.

There is, however, another remedy which would be practically sufficient to the necessities of the case, namely, the substitution of a movable dam at Tonawanda in place of the present fixed weir at that place. The lowering of the movable dam at flood time would give the relief demanded and still permit of maintaining the present summer level for the purpose of navigation. This plan would involve the construction of a lock in the canal just before it enters the creek at Tonawanda for the purpose of adjusting the difference of level whenever the movable dam were either wholly or partially opened during the season of navigation.

Again, the movable dam at Tonawanda may be considered an integral part of the proposed lift lock at Lockport. As matters now stand a considerable portion of the flood waters of the Tonawanda creek are at times discharged through the canal from Pendleton to Lockport, where they are passed through the sluiceway below the locks, into the Eighteen Mile creek. With the lift locks in operation, while not indispensible, it will still be very desirable to maintain as nearly as possible a constant level at the head of the locks at Lockport. In any case it will be necessary to provide more ample side sluices at the head at Lockport, in order to assist in maintaining a uniformity of level there, but the quantity of water is at times so large as to render its full control at Lockport very difficult, if not impossible. On the other hand, with the movable dam at Tonawanda, so far as can be judged from present information, there is no reason why the level at Lockport should vary during the navigation season more than a few inches.

It is regretted that lack of definite information as to the limits of the drainage area of the Tonawanda creek renders it impossible to present satisfactory estimates of the flood flow at this time. The problem is complicated by the large amount of flat swamp area which is also as yet only partly defined.* It is suggested therefore, in view of the considerable importance of an accurate knowledge of the topography of the Tonawanda area in connection with these projected new works, that the topographical survey be extended over that area during the summer of 1896. With the

* See report on the Oak Orchard and Tonawanda creeks in the An. Report of the State Board of Health for 1888.

information so obtained, this part of the problem may be discussed on its merits, while without it we are necessarily working mostly in the dark.

Returning briefly to the Black Rock harbor, it may be remarked that while the water power difficulty there has mostly been removed through the operation of natural causes, still it should be fully understood by all concerned, that if, through change of business conditions, there should be a disposition to revive these water powers, the navigation ought not to be subjected to any such servitude for the benefit of so small an amount of water power as can be developed at Black Rock. In any case the lapsing of the leases has probably removed this contingency.* On the other hand the State should throw no unnecessary obstacles in the way of the development of manufacturing interests by water power. Inasmuch as the general economic question involved in the relation of the State to its manufacturing interests along the line of the Erie canal is touched upon further on, we may leave this part of the discussion at this time.

By way of showing the effect on navigation of the Black Rock mills when all are operating we may refer to an unpublished report by Wm. J. Keeler, Resident Engineer at Buffalo, to John D. Fay, Division Engineer, under date of January 1, 1860.†

Mr. Keeler states that attention having been directed to the detrimental velocity of current through the Black Rock harbor investigations were instituted in September, 1859, with the following results:

(1) The aggregate quantity of water consumed by the mills when in ordinary operation was 230,000 cubic feet per minute. The maximum quantity Mr. Keeler says would be much more.

(2) The velocity of flow in the wide canal connecting the Black Rock harbor with Erie basin at Buffalo was 1.2 miles per hour=1.76 linear feet per second, while the velocity in the harbor itself was 2.2 miles per hour = 3.23 lineal feet per second. (The mean velocity of flow ought not to exceed 0.5 miles per hour, 0.733 lineal feet per second.)

* See the leases in detail for terms and conditions, Ass. Doc., 1870, No. 139, pp. 32-63.

† Manuscript report on file in the office of the Division Engineer at Rochester.

(3) Instrumental determinations revealed a surface slope from Erie street bridge to the Black Rock guard lock of 1.25 feet.

At the present time with the mills all idle the slope does not exceed one inch.

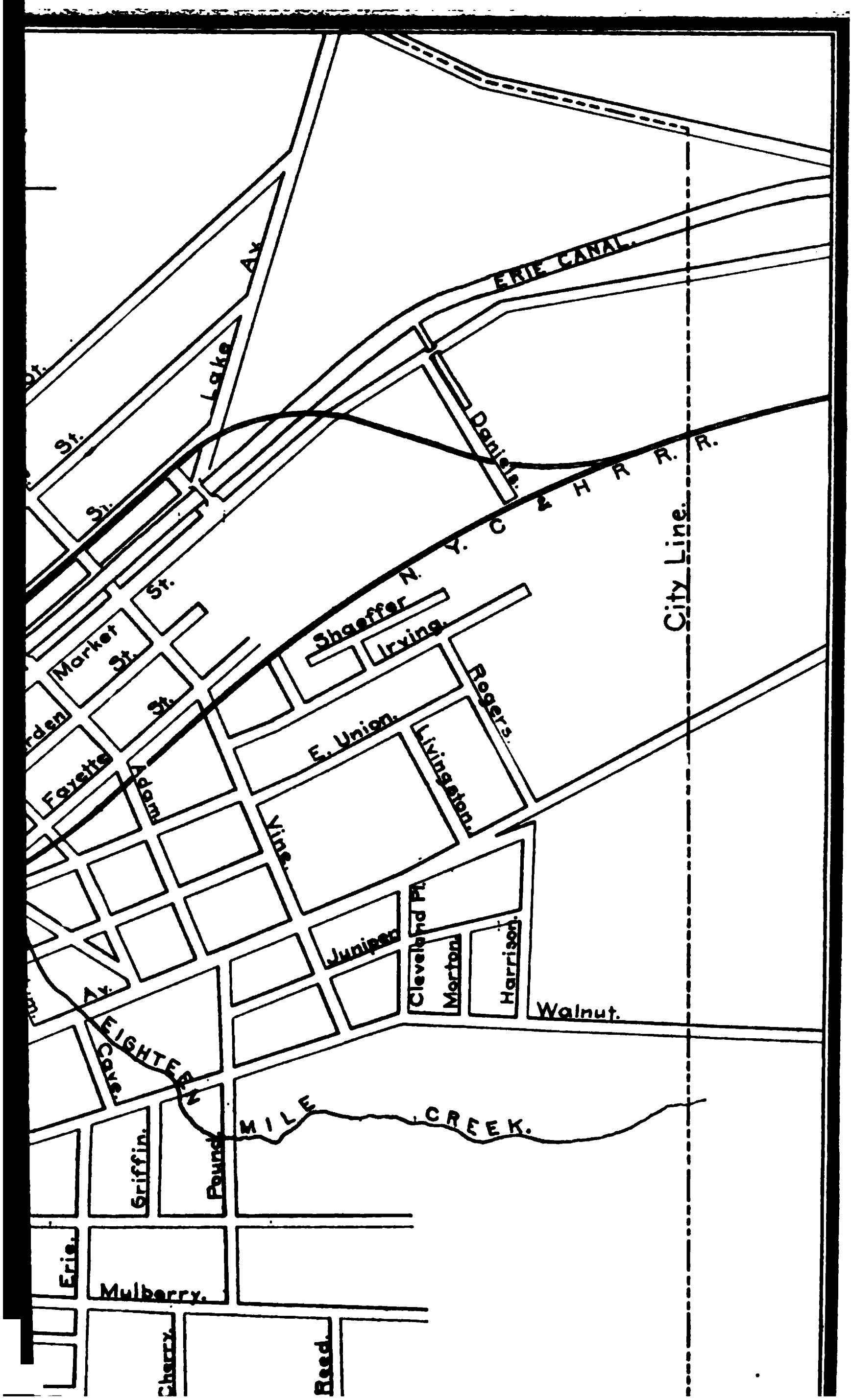
We may not take up the consideration of the water power at Lockport, where the construction of the canal through the mountain ridge created a fall of 58 feet at a single point, and where, since the use of water for lockage is only a small part of the whole flow, the balance required to feed the canal to the east of Lockport must necessarily be discharged around the locks into the lower level by means of sluiceways. The right to use this surplus was sold to Kennedy & Hatch, whose successors are the Lockport Hydraulic Power company.

Lockport has been usually considered more purely a result of the canal development than any other town in western New York, for the reason, that, while nearly all the other towns of the region had some growth before the canal was located, it was only in 1821, after the present location for the canal had been definitely decided on, that the nucleus of a village was formed by the contractors and their workmen employed on the canal. In 1820 there was no framed house or barn within five miles of Lockport and less than six hundred acres of cleared land in the four square miles of which the city of Lockport is now the center.*

When once started, however, under the impulse of the canal development, Lockport grew rapidly, until, with a population of 3,000, it was incorporated as a village by act of the Legislature in 1829. It was incorporated as a city in 1865. The population in 1896 is stated at 17,000.

In considering the significance of the development of a thriving manufacturing city at this point with the development based almost entirely on water power and where originally no water power existed, we may take into account the interesting fact that other villages in western New York, which were thriving towns before the founding of Lockport, have still been far outstripped in the final race; and in seeking for the causes we must give the water power

* Historical sketch of Lockport in Staats' Lockport City Directory for 1868-69, pp. 33-34.


ERIE CANAL.
N. Y. C. & H. R. R. R.
City Line.
Lake Av.
Daniels.
Market St.
Shaeffer
Irving.
Rogers.
E. Union.
Livingston.
Fayette
Adam
Vine.
Juniper
Cleveland Pl.
Morton
Harrison
Walnut.
Cave.
EIGHTEEN MILE CREEK.
Griffin.
Pound
Erie.
Mulberry.
Cherry.
Reed.

the chief credit. On this point the following statistics are pertinent:

From a statement furnished by Mr. Chas. T. Raymond, secretary of the Lockport Manufacturing Association, it appears that there is invested in manufacturing plants at Lockport, dependent upon the Erie canal water supply, the sum of $2,531,000. These include 33 establishments employing 1,880 operatives.

According to Mr. Raymond the power actually in use at the present time on the two raceways, taking water from the level at the head of the locks and delivering same into the long level below the locks amounts to 2,625 net horse power. Of this, 1,600 horse power is used by the Lockport Pulp company, which has only been in existence for a few years. Previous to the formation of this company the power did not exceed about 1,000 net horse power.*

A short distance to the east of the foot of the locks a small stream known as the Eighteen Mile creek crosses under the canal. This stream, although having a drainage area of only one or two square miles to the south of the canal, has still cut a deep valley with rapid fall for a considerable distance to the north of the canal. The dry weather flow of the Eighteen Mile creek is frequently almost nothing. In order to provide for discharging surplus water from the canal, an overflow into the Eighteen Mile creek was constructed at an early day. A mill was also permitted to take water from the lower level and discharge its tail water into the creek, and finally the Jackson Lumber company were permitted to construct a sluiceway on the towpath side through which they drew for many years about 18,000 cubic feet per minute, and which was all discharged into the Eighteen Mile creek. Frequently complaints having been made that boats were drawn against this sluice on the towpath side the Superintendent of Public Works in 1892 granted a formal permit to the Jackson Lumber company to construct a sluice and subway under the canal bottom whereby this water is now drawn from the berme side. Under this permit a substantial

* For detailed account of the Lockport water power, see paper, "Water Power of the New York State Canals," in Reports on water power of the United States, pt. I, vol. XVI, 10th census, 1880, where an account of the two raceways, amount of power developed at that time, etc., may be found.

masonry sluice was constructed in 1893. In the meantime the Jackson Lumber company have gone out of existence, and this water power has passed into the hands of the Traders' Paper company, who now occupy it with their pulp mill No. 1.

The Eighteen Mile creek descends about 175 feet within the limits of the city of Lockport, of which 148 feet has been utilized from water power during recent years. At present the Traders' Paper company use about 1,060 horse power; the Lockport Paper company 230 horse power; the Niagara Paper company 115 horse power; Westerman & Company 320 horse power; the Cascade Pulp company 925 horse power, and the Cowles Smelting company 1,185 horse power. The total power on the Eighteen Mile creek in the city of Lockport is therefore about 3,835 horse power.

The annual output of the establishments on the Eighteen Mile creek is stated by Mr. Raymond at about $2,000,000 per year, though this sum includes the output of the Indurated Fiber company, which, while operating by steam power, depends largely for a supply of pulp upon the Cascade Pulp company. In any case the figures show the magnitude of the manufacturing interests which have grown up here by reason of the discharge of about 18,000 cubic feet per minute from the canal into the Eighteen Mile creek.

With 2,625 net horse power in use on the canal proper, and 3,835 horse power on the Eighteen Mile creek, we have a total at Lockport dependent upon the Erie canal of 6,460 net horse power.

No statements as to the value of the manufacturing establishments on the raceways of the Lockport Hydraulic Power company have been given, and it is therefore impossible to state the value of the total annual product at Lockport with accuracy. As several of the establishments are very extensive, including among them the Holly Manufacturing company, it may be assumed that the annual output of this portion of the Lockport manufactories has a value of at least $1,000,000, whence we reach a total for the work on the canal proper and the Eighteen Mile creek of about $3,000,000.

THE OAK ORCHARD FEEDER AND THE MEDINA WATER POWER.

About the year 1820 the Canal Commissioners caused a cut-off channel to be constructed through the Tonawanda swamp, between the Tonawanda and Oak Orchard creeks, whereby the ordinary summer flow of the Tonawanda creek is diverted into the Oak Orchard creek.

This feeder was of great value during the years 1824 and 1825, while the rock cut west of Lockport was in process and before the waters of Lake Erie were available. Since 1825 it has been maintained as a subsiduary feeder only, the main supply being drawn from Lake Erie. The original channel was constructed 12 feet wide and 3 feet in depth, but it has been enlarged several times, while the present channel is 40 feet wide and 4 feet deep.

The Oak Orchard creek passes under the Erie canal at Medina, and the original feeder channel at that place was by an artificial channel leading from a dam thrown across the creek about thirteen hundred and fifty feet south of the town line between Ridgeway and Shelby, and entering the canal near the west bank of the Oak Orchard creek in the village of Medina.

At some period subsequent to 1823 a raceway for water power was also constructed leading from a second dam higher up than the feeder dam and conducting water into the central part of the village of Medina, where after its use on several water wheels it is finally allowed to pass into the canal.

During the enlargement of 1850-60, the water surface level was raised, and as such change necessitated raising the old dam somewhat, it was finally concluded to discontinue the feeder and depend entirely upon the raceway for such supply as the canal might receive at this point. The relation of the feeder to the canal is shown by Plate III.

The combined raceway and feeder of the present day has a channel leading to Maher's furniture factory on the west bank of the Oak Orchard creek near the old feeder, through which water is supplied to this furniture factory, the tail water dropping into the old feeder which also serves as a head race to the Union mill (formerly the Hoag mill) as well as to the Beach & Company's

foundry and the Bidwell Bean Thresher Works. The tail water from these three establishments is passed directly into the Oak Orchard creek without passing into the canal.*

The Oak Orchard feeder has been considered as furnishing about 1,600 cubic feet of water per minute to the canal, although gaugings made in 1850, by Mr. Thomas Evershed, who was at that time Resident Engineer on the enlargement, showed 2,000 cubic feet per minute passing through the crosscut into the Oak Orchard creek, and at the same time a flow of 200 cubic feet per minute into the creek itself. Since then the clearing up of the forests and the drainage of the extensive swamps of this region have tended to materially reduce the low water flow until at the present time it is probably in the extreme dry weather rather less than 1,600 cubic feet per minute. In the absence of definite information as to the drainage areas this question can only be discussed in a very general way at this time.

As to the future, the dry weather yield from this drainage area may be taken as somewhat less than in the past by reason of the deepening of the channel of the Oak Orchard creek and of the crosscut as authorized by chapter 136 of the Laws of 1893. This act provided for (1) deepening the channel of the Oak Orchard creek from a point two and one-half miles below where the waters of the Tonawanda enter the Oak Orchard; (2) the cleaning, improving, widening and deepening of the east channel of the Oak Orchard creek, etc. The effect of this work will be to run the water out of the swamps more rapidly in the spring, thus materially decreasing the dry weather flow.†

Taking into account, further, the demands for water power at Medina to which we have just referred, and we must conclude that this feeder is practically of little or no use for maintaining the water supply of the canal during the dry season.

---

* The side race begins at A on the map and extends to B at Maher's furniture factory. C is the Union mill and D and E are the Beach & Co.'s foundry and the Bidwell works. The water used at the mills F, G and H passes into the canal at K.

† For extended account of the Oak Orchard swamp and its relations to the feeder, see a report on the drainage of the Oak Orchard and Tonawanda swamps in the Fourth Annual Report of the State Board of Health, for the year 1883, pp. 43-116.

For extended early history of the Oak Orchard and Tonawanda feeders, see manuscript history on file in the office of the Division Engineer at Rochester.

Again more or less water has been drawn from the canal in the past for power purposes on the Oak Orchard creek below the Erie canal and there is no reason for assuming any change in this particular in the future. Extensive industries which have been fostered by the canal water supply have grown up here the same as at Lockport. The amount drawn directly from the canal is unknown, but at times can not be less than two or three thousand cubic feet per minute.

According to a statement furnished by Mr. A. L. Swet, president of the Business Men's Association of Medina, the number of operatives at present employed in manufacturing enterprises, dependent upon water power at Medina, is 515; the amount of capital invested in establishments now running is $371,000; while the value of the annual product of the same establishments is $575,000.

These figures do not include the Medina Falls flouring mill, which is standing idle at the present time. The developed water power on the combined raceway and feeder is estimated, when based on the manufacturers' ratings, at 290 horse power, the use of water at the several mills ranging from 900 to 2,620 cubic feet per minute.

The developed power at Medina on the Oak Orchard creek proper, below the Erie canal, is estimated at 537 horse power, though this figure includes the wheels at the Medina falls flouring mill, which is now standing idle. Deducting these wheels, amounting to 338 horse power, there remains 199 horse power in use on the creek at the present time. The use of water at the establishments on the creek ranges from 6,588 cubic feet per minute to 2,960 cubic feet per minute, the quantity of 6,588 cubic feet per minute being that due to the Medina falls flouring mill, where the head is 33 feet. Relative to this fine power it may be stated that it has only been idle for the last few months, and considering the amount of power available at this location it is improbable that it will remain unutilized for any great length of time. The trouble at this mill is the same as that afflicting the large flouring mills at Black Rock—the competition of cheap grain and transportation from the western mills.

The total power at Medina based on wheels actually set, may be stated at (290 + 537) = 827 horse power, or leaving out the Medina Falls flouring mill, we have as the total now in use 489 horse power.

There is also a small amount of power in use at Shelby village, on the Oak Orchard creek, about two and one-half miles south of Medina, as well as at one or two points to the north of Medina. The amount at these points aside from Medina is not known.

As to the relation of the water powers at Medina to the Erie canal we may refer to the argument of H. E. Sickles, Esq., before the Canal Board in opposition to a motion to abandon the Oak Orchard feeder.*

After reviewing the early history of the Oak Orchard feeder Mr. Sickles points out that in 1820 the lands along the Oak Orchard creek belonged to the Holland Land Company, who were extensive land owners in Western New York. This company was greatly interested in the construction of the Erie canal, and not only donated right of way, but further gave to the State 100,000 acres of land in Chautauqua county, which went into the canal fund. As regards the right of way given for the Tonawanda and Oak Orchard feeder, the consideration the company expected to receive was the great advantage to its lands, on which, through the increased supply of water and the rapid fall of the stream, a succession of valuable water privileges were created, which when dependent upon the water supply of Oak Orchard creek alone in its natural state, were comparatively of little value.

The land company, Mr. Sickles stated, were not deceived in their expectations. Very soon a large milling and manufacturing interest sprung into existence along the Oak Orchard creek and dependent upon the water furnished by the cut-off from the Tonawanda creek, which the purchasers of the land, relying upon the good faith of the State, supposed would be perpetual.

About 1829, the dam across the Tonawanda creek went out, and the State officers having hesitated about rebuilding it, Mr. David

* See proceedings of Canal Board for 1877, p. 149. Or, manuscript history of Oak Orchard feeder in office of Division Engineer at Rochester.

E. Evans, who at that time owned and operated one of the largest flouring mills in the western part of the State, at Medina Falls, entered into an agreement with the Canal Commissioners that he would build a new dam at his own expense, if the State would repair the feeder and build a bulkhead, so that the flow of water could be regulated.

This agreement was carried out by both parties, and was, as far as can be learned, the beginning or first recognition of a mutual obligation between the State and the owners of the water power on the Oak Orchard creek.

Without going further into the historical part of the subject, it may be stated in a few words that the mill owners at Medina claim that, by reason of the granting of right of way for the cut-off and the gift of 100,000 acres of land to the canal fund by their original grantor, the Holland Land Company, a part of the consideration for which was an improvement of the water power of the Oak Orchard creek, they have some equitable right to the use of the water of the feeder. If, therefore, the effect of the drainage authorized by chapter 136 of the Laws of 1893, has been to decrease the summer flow of the stream, then, it is claimed, they are entitled to enough water from the canal to make good the deficiency.

OTHER USES OF WATER ON THE WESTERN DIVISION.

The foregoing are the principal water powers on the Western Division which are in any special degree dependent upon the canal or canal constructions for a water supply. There are, however, a few small mills for which water is said to have been drawn from the canal in the past, as at Maybees, Johnson's creek and Middleport, in Niagara county. Drydocks at Lockport and Middleport have also consumed considerable water in former years. So far as can be learned, none of these are at present any serious drain upon the canal. If, however, there should be any considerable revival of wooden boat building, as the result of the present enlargement, the use for the drydocks may again become considerable, and as one object to be gained, it is in order to insure an ample supply for this purpose that it is proposed to make the supply

length. Mr. Bela Hubbard also discusses the matter broadly in a paper in the Popular Science Monthly.* Mr. Hubbard traces the relation between the secular variations, and the temperature and rainfall, and constructs curves showing the relationship from 1834 to 1887.

Taking the known fluctuations of lake level of the past, Mr. Hubbard points out that general prophecy may be made as to the future. Following this line, he predicts, from the known data, that the lake levels will rise to their culmination in about 1894, 1906, 1916 and 1927 or 1928; and fall to low levels about 1888 or 1889, 1912 or 1913, and 1921 or 1922.

In Plate IV we have the daily fluctuations at Buffalo, as kept by the United States engineers from March, 1887, to December, 1895, inclusive. From it we learn that while Mr. Hubbard's general statements are true, still his prophecy as to exact years can hardly be assented to. The most that can be said is that having the curves for a long series of years, we may expect a similar series of curves in the future, with the period of the future curve so modified as to even be at times nearly in opposition to the indication of the past curves. This point is illustrated by the curves on Plate IV, in comparison with the Cleveland curve, where we find the year 1887 a culminating point, since which time there has been a steady decline, until, in 1895, we reach the lowest year thus far recorded. Whether the lake will go lower in 1896 is as yet uncertain. We have the general changes, as pointed out by Mr. Hubbard, only with different periods from what he concluded. It is quite possible, however, that by 1927 or 1928 the general movement may coincide near enough with his assumed periods to constitute the prophecy as on the whole correct. In any case it may be remembered that Mr. Hubbard qualifies his conclusions with the guarded statement of the old almanac makers, "Look out for dry weather about — these — days." He has pointed out that the law of the movement in the past may be modified in the future.

---

* Climate of the Lake Region. By Bela Hubbard. Popular Science Monthly, vol. XXII (January, 1888), pp. 373-87.

We have, then, a series of fluctuations in which high and low alternate, and, if we would provide for an ample supply of water for the Erie canal from Lake Erie at all times, we must arrange the final grades with reference to the year of minimum elevation. The wind, while causing great variations for short periods, is still so restricted in its action that, as regards present purposes, it may be left out of the account.

By way of showing, however, the great effect of the wind on the lake surface at Buffalo, we may consider a few of the temporary fluctuations of the periods covered by Plate IV.

On January 13, 1890, the highest water was +7.6; the mean elevation for that day was +1.0, while the mean for the month was somewhat less than 0.0.*

On January 11, 1892, the lowest water was — 2.8; the mean for that day was — 2.0; the mean for the month was — 1.6.

On February 10, 1894, the lake surface rose to + 1.35, and on February 12, fell to — 4.6. The mean for the month was — 1.2.

On March 13, 1891, the highest water was + 3.2; the mean of the day was + 0.1; the mean of the month, — 0.2.

On April 9, 1890, the highest water was +4.2; the mean of that day was +0.90; and of the month +0.3.

On July 3, 1891, the highest water was +2.4; the mean of that day was +0.3; and of the month — 0.3.

On September 14, 1892, the highest water was +3.8; the mean of that day was +0.5; and of the month — 0.3.

On October 29, 1892, the highest water was + 4.6; the mean of the day was + 1.1, and of the month — 0.5.

Additional illustrations of the temporary fluctuations due to the wind can be obtained from the notes, but the foregoing may be deemed sufficient for illustrative purposes.

As shown on Plate IV, the elevation of mean lake surface is 572.23 in the Erie canal system of levels. In November, 1895 (a navigation month), the elevation for essentially the whole month was from — 2.5 to — 2.6, or, at from 569.63 to 569.73. This is the

* These statements, as taken from the diagrams, are not absolutely precise.

lowest water of any navigation month thus far known.* Makin some little allowance for possibly still lower water in the future an we may fix the extreme low-water elevation in the main Erie canal at the several inlet slips in the city of Buffalo at — 2.9 or at an elevation of 569.30.

THE AMOUNT OF WATER TO BE PROVIDED FOR IN THE PRESENT ENLARGEMENT.

As we have seen in the preceding pages there has grown up a considerable use of water power along the Western Division which is now and has been in the past the basis of great prosperity to the localities where it is situated. At Black Rock and Lockport permanent developments have been made under the authority of the legislative enactment of 1825, and other acts authorizing the sale of surplus waters; while at Medina the claim has been made of a use as by right because of the peculiar circumstances of the original grant of right of way for the Tonawanda and Oak Orchard feeder, etc. Inasmuch, then, as these water powers now consume a large amount of water, the pertinent question is at once raised as to the policy to be pursued towards them in designing the additional water supply of the present enlargement.

The Assembly committee of 1870† discussed the whole question broadly but without indicating any definite solution. As matters then existed, the committee say they would recommend, if such a thing were practicable, the abrogation of every lease and the enactment of laws prohibiting the erection of manufacturing establishments at any points where they would be in the least degree dependent upon the waters of the canal for the propulsion of their machinery. The committee, however, expressly refrain from making this recommendation; hence, we must conclude, while they do not actually say so, that they still deemed such a policy impracticable; and the great

* It will be noticed from the diagram that from November 15 to 18, 1895, the water surface rose to about —1.6 to —1.7; this was due to wind action, as was also the rise to —1.6 on November 20.

† Ass. Doc., 1870, No. 188.

growth of manufacturing industries along the canal since 1870, has rendered such a policy of suppression much more impracticable in 1896 than it was in 1870. One of the concluding paragraphs of the committee's report may be taken as representing on the whole their views, namely:

"The necessities of commerce, the interests of shippers and of mechanical industries, of agriculturists, and of all business occupations in our State, * * * and a due regard to the burdens of our taxpayers, all demand prudent and energetic attention to these questions."

At the same time, the committee held that the use of water for power purposes ought not to interfere with the efficient navigation of the canal.

In the opinion of the present writer there should be a definite policy, instead of the utter lack of policy in this particular which has characterized the management of the New York State canals for 70 years, and which has subjected the canal management to such severe criticism as the following from the report of 1870:

"Canal Commissioners and the State Engineers have, for a number of years, called attention of the Legislature to the fact that large supplies of water are needed at various points in order to secure the best navigation to the canals; but in all their reports they have failed to call attention to the fact that a large part of the complaints of a want of water resulted from the use of large amounts which were continually being drawn from the canal for hydraulic purposes, or that the water was being drawn through locks from higher to supply lower levels for the same purpose. Yet such is the fact."

In view of such an arraignment of the good faith of the canal officials, the present writer can not but think the better way is to show clearly exactly what the necessities due to existing conditions are, leaving it to the wisdom of the Legislature to decide just what the future policy of the State as sovereign shall be. In any case it may be pointed out, that, with the changed conditions of to-day, the Legislature may well be mindful of the interests of

manufacturing, as upon such development must depend very largely the business which the people of the State of New York will contribute to the support of the State canal system.

The committee of 1870, however, made one recommendation which may deserve careful consideration at the present time, namely, leases which have never been used or abandoned and no rent paid on them should be declared forfeited and cancelled, so far as is consistent with the legal rights of the parties.

In view of the present necessities it is considered that provision should be made for a minimum delivery at Lockport of 55,000 cubic feet per minute, of which 19,000 cubic feet per minute may be considered as discharged into the Eighteen Mile creek. On this point we may cite some unpublished measurements made by the engineers of the Western Division in June, 1887,* from which it appears that in the rock cut at Hutchins' bridge the flow was 49,498 cubic feet per minute. East of Exchange street bridge, below the foot of the locks, the flow was 30,984 cubic feet per minute. In the Eighteen Mile creek, at Westerman & Co.'s rolling mill, the flow was 18,708 cubic feet per minute.

In the rock cut the surface velocity at the center of the canal was 2.01 feet per second, or 120.6 feet per minute, or 1.37 miles per hour. Below the foot of the locks, east of Exchange street, the surface velocity at the center of the canal was 0.645 feet per second, or 38.7 feet per minute, or 0.44 miles per hour.

As to whether the policy of leasing the surplus waters was a mistaken one or not seems to the present writer to be now of very little moment. The important question appears rather as already pointed out to adequately provide for present necessities; and it is in view of the showing of these gaugings of 1887 that a minimum delivery at Lockport of 55,000 cubic feet per minute is suggested.

I will not consume space in further discussing the various losses of water to which canals are subject, as that question has already been considered either in the preceding pages of this report or may be found discussed in detail in the reports of Messrs. Childs and Tracy and other reports already cited. It is sufficient to say then

* F. N. Kimball. On file in the office of the Division Engineer at Rochester.

that on the long level from Lockport to lock 66, where it is proposed to leave the water surface the same as it now is, the losses of evaporation, percolation, absorption, etc., are taken at 250 cubic feet per mile per minute, and on the balance of the Western Division to the east of Rochester, where the water surface will probably be mostly raised one foot, the same losses are taken at 270 cubic feet per mile per minute.

Estimates for lockage water, leakage of gates, the drawing and swelling of boats and for turbine water wheel to operate machinery are as per the computations of Mr. Wurtele in the annual report for 1889.* As nothing can be added to the tabulations there appearing they may be used without extended discussion.

Lock 53, at Clyde, has a lift of 4.755 feet, while lock 64 has a lift of 10.108 feet. The average lift of the five locks at Lockport is 11.485 feet. We need to provide for the various uses at lock 53 to the amount of 4,200 cubic feet per minute, and at lock 64, 5,750 cubic feet per minute. In order to provide liberally for gate leakage and swelling boats out and in we will assume that this latter quantity is required at lock 53.†

In regard to Lockport, it may be remarked that the substitution of the lift-locks there will mostly do away with the lockage requirement, though there will probably be considerable demand for water to operate the new lifts. Thus far figures giving the amount of such demand are not available, and I can do no more than give it general consideration. It is believed, however, that the provision of 55,000 cubic feet per minute at Lockport is ample to cover this new demand.

We may now estimate the total requirement of water from Lockport to the east end of the Western Division at the Wayne county line.

---

* Annual report of the State Engineer and Surveyor for the year ending September 30, 1889, pp. 9-14.

† This difference in lockage requirement is due to the difference in lift. See table in report of 1889, p. 12.

	Cu. ft. per minute.
Lockage requirement, taken at	5,750
Long level, 62.5 miles	15,625
Balance of division to Clyde, 46.6 miles	12,582
Total	33,957
Add for contingencies, about 6 per cent	2,043
Amended total	36,000
Add amount to Eighteen Mile creek	19,000
Amount required at Lockport	*55,000

Of the foregoing total of 36,000 cubic feet per minute as required for the navigation, we may say that 19,600 cubic feet per minute is required to pass east of lock 66. With everything favorable the present delivery to that point can not be taken at over 14,000 to 15,000 cubic feet per minute. The long level is now mostly about 8 feet in depth, and the suggestion for this level is that the water surface be left as at present with the increase in depth made by bottoming out. This increase of about 1 foot is not enough to add very materially to the discharging capacity of this level. With a value of n=0.025 in the formula $v=c\sqrt{rs}$, we expect a discharge at lock 66 of about 18,000 cubic feet per minute, while when the roughness of the channel due to growth of water plants, etc., is such as to require a value of n = 0.03, the discharge may be taken at about 15,000 cubic feet per minute. It is considered that with different conditions of roughness the discharge at lock 66, with a depth of 9 feet, will vary between about these limits. We must, therefore, provide for taking permanently during the navi-

* The experience of seventy-five years has shown that no great degree of precision can be attained in computations of this character. The main point is to insure enough to meet the case of extreme conditions. The same general remark may be applied to computations of flow through a prism of a given cross-section and inclination. Formerly hydraulicians tacitly assumed that such computations could be made with a great degree of precision, but we now know that the coefficient of roughness may vary so greatly at different times in the same channel that the most that can be done in a general discussion is to indicate the limits within which the flow may be expected to vary. On this point see table I, in Hering & Trautwine's translation of Ganguillet & Kutter's "Flow of Water in Rivers and Other Channels." Also, a number of recent papers and discussions before the American Society of Civil Engineers.

gation season at least 3,000 to 4,000 cubic feet per minute from the Genesee river. Experience, however, indicates that in dry years we may expect to run somewhat above the normal quantity for ordinary years. From this point of view it is estimated that in such a year the demand from the Genesee river will average 4,800 cubic feet per minute.

As meeting the condition then of an extreme dry year we will base our estimate of the requirement from the Genesee river on 4,800 cubic feet per minute, thus reaching for the navigation season of 210 days a total requirement of (210 x 1,440 x 4,800) = 1,451,-520,000 cubic feet.

It is no part of my intention to discuss the Genesee river storage extensively at the present time. That subject has been treated at length elsewhere, and it is sufficient to point out here the total storage required to meet the new conditions. This may be taken as follows:

Total of extreme daily draft of 4,800 cubic feet per minute	1,451,520,000
Required for filling	302,400,000
*Reserve for breaks	746,080,000
Total requirement	2,500,000,000

GRADES AND WATER SURFACE LEVELS FROM BUFFALO TO LOCKPORT.

Having given, in the preceding discussion, an account of the real status of the water supply of the Western Division, as well as the controlling elements governing the design of the water supply of the deepened canal of this date, we may now take up a study of the profile and cross-sections, with special reference to the work in hand.

For the necessary computation of flow we will use the formula

$$v = c\sqrt{rs}$$

in which

* For this part of the subject in some greater detail, see annual report of State Engineer and Surveyor for the fiscal year ending September 30, 1890, pp. 435-437.

v = velocity in lineal feet per second,

$r = \frac{A}{P}$ = area divided by wetted perimeter,

$s = \frac{h}{l}$ = head divided length, and

c = a coefficient dependent upon the values of r, s and n. We will take n as varying between 0.025 and 0.03.

In the preceding discussion, we fixed the extreme low-water level of Lake Erie at 569.30, and this may be considered as the water surface level in the canal at the several supply slips in the city of Buffalo.

Allowing something for surface slope between Buffalo and the Black Rock guard lock, we may take the extreme low-water surface at the lock at 569.00. We have then a surface slope of between Buffalo and the guard lock of 0.3 feet.

If we apply computation to this section of canal 22,000 lineal feet in length and with cross-section when deepened varying from 1,225 square feet to 750 square feet, we obtain, with values of (n) between 0.025 and 0.03, and an assumed discharge of 60,000 cubic feet per minute, a slope of 0.3 feet.

We have assumed 60,000 cubic feet per minute for this section of the canal in order that, allowing for the various losses of evaporation, percolation, absorption, etc., we may insure the required quantity of 55,000 cubic feet per minute at Lockport.

We may note that the determination of a slope of 0.3 feet from Buffalo to the Black Rock guard lock is on the basis of a closed channel for the canal through the harbor. So long, however, as free communication exists between the harbor and the canal (and the mills are idle), the slope will be only a small fraction of 0.3 feet.

It may be further remarked that with extreme low water, the velocity of flow will necessarily be considerably in excess of that generally assumed as the most favorable, namely, one-half mile per hour, or 0.733 lineal feet per second. A study of the lake fluctuation record is, however, reassuring on this point, as from it we learn that it is only once in a long series of years that the extreme low water occurs; while with Lake Erie at or near its mean elevation the cross-section in the canal is increased so greatly that

the velocity of flow is fairly within or near the assumed limits. This view applies to all of the canal between Buffalo and Lockport, except the wide Tonawanda creek, where the great width, as well as depth, insures a low velocity as well as a sufficient supply at all times.

Again, improved methods of propulsion may be expected to render a relatively high velocity for short distances of less importance in the future than in the past.

We may begin then at the Black Rock guard lock with an elevation of extreme low water of 569.00, and computing with reference to a minimum delivery of 55,000 cubic feet per minute at Lockport we find, with n = 0.03, the following elevations of grade at the several points:

Black Rock guard lock	569.00
Tonawanda	568.11
Pendleton*	567.89
Sulphur Spring guard lock	567.65
Head of rock cut	567.24
Head of Lockport locks	567.00

If we repeat the computation with n = 0.025 for all the reaches of canal, we obtain the following elevations:

Black Rock	569.00
Tonawanda	568.33
Pendleton	568.11
Sulphur Springs	567.93
Head of rock cut	567.64
Lockport	567.49

It is considered, therefore, that in times of minimum flow the water surface may be expected to vary within about the foregoing limits.

Between Black Rock and the Tonawanda creek it is proposed to make the bottom grade 10 feet below the computed extreme low water surface. The cross-section of this portion of the canal will

* From Tonawanda to Pendleton, through the Tonawanda creek, where there is an excess of section, n = 0.025 has been used.

range, when deepened to 10 feet from about 915 square feet to 465 square feet. This entire reach of canal ought to be widened to a cross-section of at least 900 square feet, as well as given a depth of at least 10 feet. Without such increase it will remain a place of difficulty in time of extreme low water. The computations of low water surface have been made on the basis of such an enlargement.

Through the Tonawanda creek, from Tonawanda to Pendleton, the bottom grade may be placed nine feet below the low water surface grade.

From Pendleton to Sulphur Spring guard lock we have a reach of canal which gives with nine feet depth at times of extreme low water a cross-section of about 800 square feet.

From the Sulphur Spring guard lock to west end of rock cut, it is proposed to make a depth of 10.5 feet, which is increased to 13 feet at the beginning of the rock cut and continued at that depth to Lockport.

With the foregoing dimensions, and adverse conditions as to the height of Lake Erie and roughness of channel, we may expect to deliver 55,000 cubic feet per minute at Lockport, and still not exceed a velocity of 1.13 lineal feet per second at any point. In the rock cut the velocity will be slightly less. These, too, it may be pointed out are the extreme low water velocities; for ordinary height of water they will be less.

The mean velocity of 1.13 lineal feet per second, equivalent to 0.77 miles per hour, is 0.27 in excess of 0.50 miles per hour, which has been usually taken as to the figure which ought not to be exceeded. E. Sweet, M. Am. Soc. C. E., has given in his report as Division Engineer, for the year 1878,* an elegant mathematical analysis of this problem in which he shows, that, taking into account the excess of the traffic to the east over that to the west, the most economical velocity would be even somewhat less than 0.50 miles per hour. This demonstration is based upon traction experiments made by Mr. Sweet, as to the power required to propel one of the ordinary Erie boats of the usual pattern, and drawn by two horses; and while true for the assumed conditions, still, it may be pointed

* An. Rept. State Engineer and Surveyor, for the year ending September 30, 1878.

out that a stronger propulsive power, such as we seem likely to soon have by the application of electricity to canal traction, greater differences of velocity will be — within limits, and for short distances at any rate — of relatively less importance than at present; hence, for a short reach of canal, such as we have between Lockport and Pendleton, or between Tonawanda and Black Rock, a somewhat higher velocity than 0.50 miles per hour may be deemed permissible. In the Tonawanda creek, between Tonawanda and Pendleton, the cross-section is so great as to insure at all times a very low velocity.

As to the relative advantage of deepening versus widening, in order to obtain a given increase in the delivery of such a water channel as the rock cut west of Lockport, the advantage lies with deepening, because an increase in delivering capacity without increase of slope depends very materially upon an increase of the mean hydraulic radius. With the present section of the rock cut 62 feet wide at top and bottom, and 9.5 feet depth of water, we have:

$$r = \frac{A}{P} = \frac{589}{81} = 7.3$$

With the same width, and depth increased to 13.0 feet, we have:

$$r = \frac{806}{88} = 9.2$$

With the depth remaining 9.5 feet, but with the cut widened out to give a sectional area of 806 square feet, the same as would be obtained by deepening to 13.0 feet, we have:

$$r = \frac{806}{103.9} = 7.8$$

Assuming the same slope in each case and the values of c, corresponding to these several values of r are: for $r = 7.3$, $c = 81$; $r = 7.8$, $c = 82$; and for $r = 9.2$, $c = 86$.

Taking into account that an increase of width of 22.9 feet — the dimension required in order to give 806 square feet sectional area — would necessitate the removal of a considerable portion of the old spoil banks, which were left very near the top of the cut, and we may conclude that the necessary additional area may be obtained nearly as cheaply by deepening as by widening, with the advantage of some increase in delivery for a given slope.

THE LONG LEVEL.

We may now briefly consider the long level, the total length of which is 62.49 miles, and the total surface fall, 3.165 feet. The depth is now 8.0 feet at Lockport and 7.84 feet at lock 66. At several intermediate points the depth is somewhat less; as for instance, near the Four-mile grocery, 7.70 feet; near Norman's bridge, 7.57 feet, at which depth it continues on west to near the Transit road bridge; from which point the depth gradually increases to 8.0 feet at the foot of the locks at Lockport. On the Genesee river aqueduct the depth on the highest point of the bottom is 7.72 feet, but this is only for a short distance at the east end of the structure. There is also one point where the depth is 7.82 feet, but for the balance of the structure the depth is fully 8.0 feet. It is considered that there can be no difficulty in relaying the concrete in the bottom of this aqueduct at such elevation as to give full 8.0 feet depth at every point. It is suggested, therefore, that the water surface on the long level be left the same as at present, the full depth of 9.0 feet being secured at all points, except on the Genesee aqueduct, by bottoming out. If in the future it appears desirable to make 9.0 depth on this aqueduct it will be a question of expense purely; so far as can be learned there is no serious engineering difficulty in the way.

The delivery of the long level to the east of lock 66 has been discussed on page 216. Since the adjustment of the water surfaces of the deepened levels to the east of lock 66 is not essential, under the existing conditions, to a consideration of water supply questions, I have terminated my special studies at lock 66.

The special data herein embodied is as furnished by the Division Engineer of the Western Division.

In conclusion it may be remarked that the urgent request for the completion of this report before the cross-sections were all available has prevented going into the question of actual delivery of water quite as minutely as I should otherwise have done. It is believed, however, that the information was sufficient for the conclusions here set forth.

Very respectfully,

GEO. W. RAFTER.

APPENDIX II.

Annual Report for Year Ending September 30, 1896.

Hoffman and Swinburne Islands

AND

HEALTH OFFICER'S STATION.

Enlargement of Hoffman Island.

The appropriations made for this work were as follows:

By chapter 486, Laws of 1894	$160,000
By chapter 932, Laws of 1895	75,000
Total	$235,000

PROGRESS OF THE WORK OF ENLARGEMENT.

The following statement shows the total amounts of the different items of work done from the beginning of the enlargement up to October 1, 1896, also the total cost of the same at contract prices, the payment made and the percentage retained:

Work done and material furnished up to October 1, 1896, *by P. Sanford Ross, contractor, under his contracts, dated the 4th day of September*, 1894, *and the 26th day of June*, 1895, *for the enlargement of Hoffman Island, New York Harbor* (*chaps.* 486, *Laws of* 1894 ; 932, *Laws of* 1895.)

Quantities.	ITEMS.	Contract price.	Relative price.	Amounts.	Percentage retained.	Amount of payment.
104,800	Cubic yards embankment........	$0 28	....	$29,344 00		
36,400	Cubic yards embankment.......	21	....	7,644 00		
2,133	Cubic yards excavation, old rip-rap	2 50	....	5,332 50		
6,100	Cubic yards stone filling in cribs	83	....	5,063 00		
42,800	Cubic yards rip-rap stone in place	83	....	35,524 00		
52	Cubic yards American Portland cement concrete..............	7 00	....	364 00		
4,868	Cubic yards coursed rubble masonry in American Portland cement.......................	5 75	....	27,991 00		
2,254	Cubic yards coursed ashlar, including coping, in American Portland cement..............	14 00	....	31,556 00		
1,385,000	Ft. B.M., southern pine timber in place per M.................	29 00	....	40,165 00		
97,300	Lbs wrought iron, per lb........	03½	....	3,405 50		
17	Gross tons cast iron per gross ton	35 00	....	595 00		
					$186,984 00	
	Extra Work.					
	For labor, materials and necessary expenses for taking up and relaying salt water pipe, not covered by contract:					
	For labor..................	......	....	$41 00		
	For pipe, elbows, flanges, etc....	......	....	53 05		
	For expenses, board of men, cartage, etc....................	......	....	14 45		
					108 50	
	For Tee landing and landing in Old Slip, including float, not covered by contract:					
3,547	Lin. ft. white oak piles driven, per lin. ft.....................	......	$0 40	$1,418 80		
31,700	Ft. B.M., southern pine timber, per M........................	......	32 50	1,030 25		
	For labor on gangway, due to change in plan................	......	....	28 48		
	For labor on stairway and float in Old Slip.....................	......	....	92 50		
					2,570 03	
	For extra cement used in rubble wall, due to change in composition of mortar :					
250	Bbls. American Portland cement per bbl.......................	......	1 95	$487 50		
					487 50	
	Deduct materials furnished by State.					$190,150 03
1,929	Cubic yards old rip-rap stone...	75	....	$1,446 75		1,446 75
	Total estimate to date........	......	....	....	....	$188,703 28
	Total estimate say.............	......	....	$188,700 00		
	Fifteen per cent. retained......	......	....	28,305 00		
	Amount of payment to Oct. 1, '96	......	....	$160,395 00		

The following statement, arranged by months, from the beginning of the work, shows the amount of contract work done, the percentage retained and the amount of payment to October 1, 1896:

MONTH.	Year.	Total amount of work done.	Percentage retained.	Amount of payment.
October	1894	$8,400	$1,260	$7,140
November	1894	9,740	1,461	8,279
December	1894	3,940	591	3,349
January	1895	6,160	924	5,236
February	1895	2,300	345	1,955
March	1895	6,040	906	5,134
April	1895	7,100	1,065	6,035
May	1895	6,280	942	5,338
June	1895	3,500	525	2,975
July	1895	12,940	1,941	10,999
August and to September 13	1895	7,680	1,152	6,528
September 13 to October 1	1895	12,060	1,809	10,251
October	1895	11,060	1,659	9,401
November	1895	6,720	1,008	5,712
December	1895	5,220	783	4,437
January	1896	1,540	231	1,309
February and March	1896	1,280	192	1,088
April	1896	3,840	576	3,264
May	1896	8,820	1,323	7,497
June	1896	17,680	2,652	15,028
July	1896	14,060	2,109	11,951
August	1896	18,060	2,709	15,351
September	1896	14,280	2,142	12,138
Totals	......	$188,700	$28,305	$160,395

Total expenditures for printing, and advertising to October 1, 1896:

DATE.	Printing.	Advertising.
September 19 to December 31, 1894	$49 30	$140 80
January 1 to March 1, 1895	18 00	....
Totals	$67 30	$140 80

EXPENDED FOR ENGINEERING.

The entire work of enlargement, including inspection, has been in charge of a corps of engineers from the Department of the State Engineer and Surveyor. The salaries and expenses of the corps have been paid from the sums appropriated for the enlargement.

The following statement shows the total expenditures for this purpose, and includes engineering supplies and board of engineers on the island up to October 1, 1896:

FOR THE MONTH OF	Year.	Salaries, expenses and board.	Engineering supplies.	Remarks.
Sept. 19, 1894, to Oct. 16, 1895	....	$9,586 71	$32 00	
Oct. 16, 1895 to Jan. 1, 1896	....	2,384 72	8 55	
January	1896	238 42	....	
February	1896	377 64	....	
March	1896	....	....	Paid from Swinburne Island fund.
April	1896	227 63	....	
May	1896	589 10	....	
June	1896	627 09	....	
July	1896	769 34	....	
August	1896	790 47	....	
September	1896	851 83	....	
Totals to October 1, 1896	....	$16,387 95	$40 55	

Summary of the total cost of work, engineering and other expenses, from the beginning of the enlargement up to October 1, 1896, also the amounts due and paid up to that date:

ITEMS.	Total liabilities up to October 1, 1896.	Amounts paid up to October 1, 1896.	Amounts remaining due October 1, 1896.	Remarks.
Contract work	$188,700 00	$160,395 00	*$28,305 00	
Printing	67 30	67 30	....	
Advertising	140 80	140 80	....	
Engineers, salaries, etc	16,387 95	16,387 95	....	
Engineers' supplies	40 55	40 55	....	
Totals	$205,336 60	$177,031 60	*$28,305 00	

REPAIRS TO RIP-RAP ON SWINBURNE ISLAND.

The Legislature, by chapter 932, Laws of 1895, appropriated the sum of $10,000 for these repairs. The work is nearly completed.

The following statement shows the total amounts of the different items of work done from the beginning of the repairs up to October 1, 1896:

*Fifteen per cent. retained on payment.

Work done and materials furnished by P. Sanford Ross, up to October 1, 1896, *under his contract dated the* 26*th day of September*, 1895, *for the repairs to rip-rap on Swinburne Island.* (*Chapter* 932, *Laws of* 1895.)

Quantities.	ITEMS.	Contract price.	Amounts.	Totals.	Total cost of work done.
5,920	Cubic yards rip-rap stone in place	$0 92½	$5,476 00		
31	Cubic yards Portland cement concrete in place	10 00	310 00		
129	Cubic yards stone coping in place	15 00	1,935 00		
				$7,721 00	
	Extra work				
	For removing and replacing old rip-rap and for removing ashes not covered by contract	....	$48 80	48 80	
	For recutting stones around flag pole, crematory and receiving vault not covered by contract	....	$27 20	27 20	
					$7,797 00
	Total estimate say	....	$7.800 00		
	Fifteen per cent. retained	....	1,170 00		
	Amount of payment to Oct. 1, 1896	....	$6,630 00		

The following statement, arranged by months, from the beginning of the work, shows the cost of the work done by the contractor, the percentages retained and the payments made:

MONTH.	Year.	Total cost of work done.	Percentages retained.	Payments made.
December	1895	$840 00	$126 00	$714 00
January	1896	1,380 00	207 00	1,173 00
February and March	1896	500 00	75 00	425 00
April	1896	1,380 00	207 00	1,173 00
May	1896	1,040 00	156 00	884 00
June	1896	340 00	51 00	289 00
July and August	1896	1,340 00	201 00	1,139 00
September	1896	980 00	147 00	833 00
Totals	......	$7,800 00	$1,170 00	$6,630 00

The total expenditures for advertising and printing up to October 1, 1896, are as follows:

For advertising	$49 00
For printing	6 42
Total	$55 42

The following statement shows the total expenditures for engineers, including salaries and board, and cost of a rowboat for engineers' use, up to October 1, 1896:

FOR THE MONTH OF	Year.	Salaries and board.	Supplies.	Remarks.
January	1896	$134 75	....	....
March	1896	289 78	....	....
April	1896	253 18	....	....
July	1896	50 85	....	....
November	1896	59 95	....	....
May	1896	....	$100 00	Rowboat.
Totals	....	$788 11	$100 00	

Summary, showing the total cost of contract work, engineering and other expenses, for the repairs to rip-rap on Swinburne Island, up to October 1, 1896:

ITEMS.	Amounts paid.
Contract work	$7,800 00
Advertising and printing	55 42
Engineering	788 11
Rowboat	100 00
Total	$8,743 53

The entire work of repairs to rip-rap, including inspection, on Swinburne Island, has been in charge of the corps of engineers detailed from the Department of the State Engineer and Surveyor for duty on Hoffman Island enlargement.

BOAT LANDINGS ON SWINBURNE ISLAND.

There are two boat landings on this island, one on the west side, the other on the south side.

The one on the west side is a Tee-shaped landing, the top of the Tee being about 180 feet long and 30 feet wide, with a stem about 140 feet long and 28 feet wide. It consists of a cribwork of timber filled with stone and rests on a pile foundation.

The south end of the top of the Tee is settling and breaking away; the stone in the cribwork will soon fall into the water in front of the landing, and the remaining portion of the landing will be left in a

condition liable to be greatly damaged, if not totally destroyed, by the action of the water in times of storms.

Some of the foundation piles have broken off, and it is possible that there were not enough piles driven in the foundation to give the required support for the crib and stone, and the weight that might be placed upon the deck.

The damaged portion can not be used, it may cause the total destruction of the entire landing, and as an obstruction may cause the loss of a boat. Repairs should be made at once.

To remove and rebuild the damaged portion will require an expenditure of about $3,000.

To rebuild an entire new top of Tee, independent of the old one, will require an expenditure of about $5,000.

The landing on the south side is a temporary one, Tee-shaped and was constructed from a few piles, timbers and plank; its location is the best for entrance from the main ship channel, but, in its present condition, it is unsafe for the landing of passengers and can not be used for unloading freight. It is in constant use and should be replaced by a substantial pile landing that could be used for both passengers and freight.

Plans and estimates have been prepared for such a landing in this location, the estimated cost of which is $3,500.

SUBMARINE TELEPHONIC AND TELEGRAPHIC CABLE BETWEEN STATEN ISLAND, HOFFMAN AND SWINBURNE ISLANDS.

By an act of the Legislature (chapter 950, Laws of 1896), the sum of $8,000 was appropriated for "substituting telephonic and telegraphic communication between the mainland and the quarantine islands, including submarine cable."

The board of commissioners, after consultation with several firms, skilled in this class of work, as to the plan, materials and cost, finally decided to accept the proposition of W. R. Brixey, of 203 Broadway, New York city, who offered to do the work complete for the sum of $7,750.

A contract was made and executed on the 2d day of July, 1896, wherein Mr. Brixey agreed to complete the work within sixty days of the contract date.

The work was completed within the time specified, and a test made shows the entire plant to be in a satisfactory condition for use.

The remainder of the appropriation ($250) will be paid to the New York and New Jersey Telephone Company for telephonic exchange service, from October 1, 1896, at Hoffman and Swinburne Islands, and the health officer's station on Staten Island, in accordance with a contract made with said company and dated the 17th day of September, 1896.

HOFFMAN AND SWINBURNE ISLANDS, FRESH WATER SUPPLY.

The sum of $8,000 was appropriated by chapter 358, Laws of 1894, for the construction of a pipe line for fresh water supply for Hoffman and Swinburne Islands.

This sum was found to be insufficient to lay the amount of pipe required, more than two miles in length of four and six-inch pipe, together with the necessary hydrants and other attachments.

By an act of the Legislature (chapter 950, Laws of 1896), the sum of $8,000, appropriated by chapter 358, Laws of 1894, was reappropriated for the purpose of attempting to obtain water by driven wells, and increasing the water supply by such means as the board of quarantine commissioners might deem proper.

The board of commissioners finally decided to sink an artesian well on Hoffman Island, and invited proposals from specialists in this line of work. Two proposals were received, as follows:

FROM THE HYDRAULIC CONSTRUCTION COMPANY, 145 BROADWAY, NEW YORK.

To sink an eight-inch well for the sum of $6.50 per foot for the first 300 feet, and $8.50 per foot for any depth beyond that, reserving the right as the depth increased to reduce the size of the well, but not to a diameter of less than 4 7-10 inches.

FROM ELISHA GREGORY, 48 CHURCH STREET, NEW YORK.

To sink an eight-inch well 100 or more feet in earth or rock on Hoffman or Swinburne Islands, or on both, for the sum of $6 per foot for each and every foot so driven from the surface of the ground, using the best eight-inch pipe and steel shoe with twelve-foot Cook's patent strainer, swedging it out and leaving well complete to surface of ground.

If good water is not obtained above rock to drill in rock 1,000 feet if required.

To furnish all labor, tools, machinery and materials, except coal and fresh water, that will be needed in the prosecution of the work.

To be paid the sum of $200 for furnishing, handling and operating a suitable boiler and engine for prosecuting the work.

To be furnished, free of charge, the necessary coal and fresh water for running the engine and machinery in the prosecution of the work.

The board of commissioners awarded the contract to Elisha Gregory, the lowest bidder, and a contract was executed between Elisha Gregory and the people of the State of New York, represented by the board of commissioners, created by chapter 270 of the Laws of 1888, on the 1st day of July, 1896.

The contractor began driving pipe in July and up to October 1, 1896, has driven a total of 252 feet of eight-inch pipe.

The following statement, arranged by months, shows the cost of the work done by the contractor, the percentages retained and the payments made up to October 1, 1896:

FOR THE MONTH OF	Year.	Cost of work done.	Percentages retained.	Payments made.
July and August	1896	$1,300 00	$195 00	$1,105 00
September	1896	260 00	39 00	221 00
Totals	....	$1,560 00	$234 00	$1,326 00

The driven well work is in the charge of the engineer corps, detailed from the Department of the State Engineer and Surveyor for duty on the Hoffman Island enlargement.

REPAIRS TO DOCK AND DREDGING THE SLIP AT THE HEALTH OFFICER'S STATION.

The dock is in bad condition, much of the timber work is decayed and broken, some of it is gone.

The slip should be dredged without delay, there is barely room for one boat to enter and the depth of water is insufficient to safely float boats at the low water stage and in times of storms.

Careful soundings have been taken and an examination of the dock made in order to arrive at an estimate of the cost for dredging the slip and repairing the dock.

The following estimate of quantities and cost is for dredging the slip so as to obtain a depth of twelve feet at mean low water, and for repairing the dock as much only as will be actually necessary to make it safe for use:

Quantities.	ITEMS.	Price.	Amounts.
2,300 cubic yards.	Materials dredged that can be removed by an ordinary clamshell dredge, per cubic yard............	$0 18½	$425 50
3,100 cubic yards.	Materials dredged that can not be removed by an ordinary clamshell dredge, except boulders over one-half a cubic yard in content, and solid ledge, per cubic yard	50	1,550 00
6,000 ft. B. M....	Southern pine timber and plank in place, per M. ft. B. M....................................	40 00	240 00
20	Spruce face piles up to 50 feet in length in the work, per pile..	5 00	100 00
5	Old face piles, pulled, redriven and secured to the dock, per pile..	2 50	12 50
35	White oak fender piles, 50 feet and up in length, secured in the work, per pile........................	18 00	630 00
20	Old piles secured to the dock, per pile................	1 50	30 00
6,300 pounds.....	Cast iron mooring posts secured to dock, per pound...	4	252 00
	Total	....	$3,240 00

APPENDIX III.

All Matters Pertaining to Boundary Line Monuments.

Joint Report on the Monuments Marking the Boundary Line Between the State of New York and Pennsylvania.

ALBANY, N. Y., *December* 31, 1896.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.—We, the undersigned, have the honor to submit this, our joint report, on the condition of the monuments marking the boundary line between the States of New York and Pennsylvania, undertaken in pursuance of the following articles of agreement.

Whereas, by virtue of the provisions of chapter 421, of the Laws of the State of New York, the State Engineer and Surveyor is authorized and required, during the year 1887, and every third year thereafter, to cause to be made an examination and inspection of the boundary line monuments between that State and other States adjoining, and is further required to make a detailed report of such inspection and examination; and is further authorized and required to co-operate with the proper authorities of such adjoining States, in the examination and inspection and in the restoring and replacing of boundary line monuments, where they need to be restored or replaced, and is clothed with full authority to represent the State of New York in co-operating with other States in discharging the duties hereinbefore referred to regarding boundary line monuments; and

Whereas, similar duties are imposed upon the Secretary of Internal Affairs of the Commonwealth of Pennsylvania, by the second section of the act of the General Assembly, approved May 4, 1889, entitled "An act relative to the boundary lines and boundary line monuments," directing his co-operation with the proper authorities in any of the adjoining States in re-establishing, by survey or otherwise, of the boundary lines, the erection of new monuments to mark their location, the repairing, resetting or renewing of the

old monuments when found necessary; and by virtue of said act is fully empowered to represent and act for the Commonwealth of Pennsylvania, by the employment of such means as may be necessary in the premises, when from the reports of the county commissioners of said commonwealth, or from other information satisfactory to him, it is found there is a necessity for the resurvey and relocation of said boundary lines, in whole or in part, or whenever any of the boundary line monuments are in such condition as to require resetting, replacing or renewing; and,

Whereas, by virtue of the laws referred to in the two States named, the said State officers are required to co-operate with each other and act jointly in the examination and inspection, and, when found necessary, in resetting, replacing and renewing of monuments and in the re-establishing of the boundary lines between said States; and,

Whereas, it appears from the examinations made in the years 1890 and 1893 that these monuments are displaced in whole or in part frequently by the action of frost, floods and by other causes, making their frequent examination desirable to the end that they may be maintained in their proper position and condition; and it appearing that the welfare of the two States named will be conserved by an examination and inspection of said boundary line monuments during the present year, and by virtue of the duties imposed upon the officers named by the respective States, as appears from the enactments in part recited; therefore,

It is agreed, by and between the undersigned, acting in conformity with the authority conferred, as hereinbefore stated, that Charles H. Flanigan, representing the State of New York, under appointment made by Campbell W. Adams, State Engineer and Surveyor of the said State of New York, and John W. Schall, representing the State of Pennsylvania, under appointment made by James W. Latta, Secretary of Internal Affairs of the said State of Pennsylvania, shall be empowered, and by these presents, are hereby empowered, to cause to be repaired, reset and replaced any of the said boundary line monuments, which in their judgment may need to be so repaired, reset or replaced; and,

It is further agreed that the parties herein named shall have full authority to represent the respective States in the discharge of the duties herein imposed, limiting the scope of their authority, however, to the examination of the boundary line monuments, between the two States, and to the replacing, resetting and repairing of such monuments, as in their opinion should be repalced, reset or repaired, and to the furnishing and setting of new monuments where the old ones are so far mutilated and destroyed as to render them unserviceable; it being understood that in case the examination and inspection, to be made, shall disclose the fact that there is a necessity for the resurveying of any part of the said boundary line, for the purpose of determining its location, the engineers appointed, as aforesaid, shall have no authority to make such survey, until they shall have first reported the conditions to the parties hereto, which conditions, in their opinion render such a resurvey a necessity, nor until written authority signed by both of the parties hereto shall be given them, authorizing such resurvey; and,

It is further agreed, That the engineers, herein referred to, and appointed under the authority mentioned, shall proceed at once to the discharge of the duties as set forth and shall diligently prosecute the work of examination and inspection and the discharge of the other duties to be done and performed, in order that the work shall be completed at as early a day as practicable; and,

It is further agreed, That upon the completion of the work, provided for in this agreement, a full report shall be prepared of their operations, which report shall give in detail the location and condition of each monument and other interesting data pertaining thereto, as well as a statement of such action as may have been taken in regard to the same, such report to be made in duplicate, each to be signed by both the engineers, one to be filed with the State Engineer and Surveyor of the State of New York, at Albany, and the other to be filed with the Secretry of Internal Affairs of the Commonwealth of Pennsylvania, at Harrisburg; and,

It is further agreed, That the actual expenses incurred in the discharge of the duties herein referred to shall be borne equally by the two States in interest, except so far as may relate to the compensation of the two engineers referred to, which compensation is

to be arranged by each State separately, and that all expenses be accounted for in verified statements, and, so far as practicable, supplemented by receipted vouchers from parties to whom disbursements have been made.

In witness whereof, Campbell W. Adams, State Engineer and Surveyor of the State of New York, and James W. Latta, Secretary of Internal Affairs of the Commonwealth of Pennsylvania, have hereunto set their hands and caused the seals of their respective departments to be hereunto affixed, this 25th day of September, 1896.

CAMPBELL W. ADAMS,
State Engineer and Surveyor.
JAMES W. LATTA,
Secretary of Internal Affairs.

Monuments marking this line are divided into five classes.

FIRST CLASS—HIGHWAY MONUMENTS.

These are placed at highways intersecting or following the boundary line. Milestones placed alongside highways are of this class. These monuments are four and one-half feet long; the top is dressed rectangular, twelve inches by six inches, and at right angles across the center, parallel with the edges are cut two quarter-inch grooves; the upper end of each side to the depth of twelve inches is also dressed, and upon one broad (north) face is cut the letters "N. Y." and upon the other (south) the letters "Pa." The milestones of this class are further marked with the number of the original mile monument and the letter "M." These monuments weigh from 375 to 500 pounds. In setting monuments of this class, the longer groove was placed in the direction of the boundary.

SECOND, THIRD AND FOURTH CLASSES.

Monuments of the second, third and fourth classes are four feet long, the top is dressed six inches square, and the upper end of each side is also dressed to the depth of six inches. These monuments weigh from 170 to 220 pounds.

Monuments of the second class are placed at the original mile points, which are not marked by monuments of the first or fourth

classes. Across the top at right angles and parallel with the faces, are cut two-quarter inch grooves; on opposite faces are cut the letters "N. Y." (north) and "Pa." (south), and upon a third (east face) the number of the original monument, with the letter "M." under it.

Monuments of the third class are similar in all respects to monuments of the second class, with the exception that the number upon the third face is omitted except in a few instances. They are placed at railway and river intersections and at such other points as were deemed necessary. Monuments of the second and third classes are set so that the faces containing the letters "N. Y." and "Pa." are parallel with the boundary.

Monuments of the fourth class have cut, diagonally across their top two quarter-inch grooves, and they are set so that one of the diagonal grooves is in the direction of the boundary. The faces are specially lettered. These monuments are generally milestones marking the town or county corners; the face of the stone toward the town or county is marked with the initial letter of the name.

FIFTH CLASS.

Monuments of this class are placed to mark the astronomical stations of the United States Coast and Geodetic Survey, occupied in 1877 and 1879. Each monument is a block of granite of the general dimensions of twelve inches square and eighteen inches or more deep. The top is dressed and the station point is marked upon it in the center by a cross (X). Upon the top are also cut the name of the station, the letters "U. S. C." and "G. S." and the year in which the station was occupied.

The monuments of this class were not examined, as they are all buried beneath the surface.

Considering the open and exposed places in which many of the monuments stand, they were generally found to be in good condition; some of them were more or less chipped at the corners and sides, but not to a sufficient extent to affect their usefulness; some have heaved from 1 to 12 inches above their normal posi-

tions, one is missing; one has been destroyed by fire and one has been maliciously broken.

The great majority of the monuments which show an excessive upheaval, stand in wet swampy ground and no special means were taken in the setting of these monuments to prevent an upheaval due to the action of frost. To attempt to reset every monument which has heaved to any extent, would be unnecessarily expensive, and productive of no good result, for while many of them have heaved, yet they stand firmly and answer the required purpose. It is suggested that only such monuments as have heaved eight inches or more be reset, and that in the resetting where the ground is wet, concrete be placed at the bottom and around the monument to within a foot of the surface of the ground. This course seems necessary because some of the monuments which were reset in 1893, with the greatest care, again show an upheaval of more than eight inches.

The examination of the line through the woods involves more time and labor at each succeeding examination, owing to the fact that the cutting, which was made when the line was run, and the monuments set and which was discernible and easily followed on the previous examinations, has now grown up to bushes and can not be distinguished from other parts of the woods. A most careful scrutiny failed to disclose any evidence that trees along the line had been blazed by the surveying party of 1884; in a few instances line trees were found marked, probably by the lumbermen, but there was usually such an uncertainty attached to them, that they served but little purpose, and at times caused confusion. There were many occasions where hours would have been saved by the existence of some line trees.

There seems to be no practical way in which this defect can be remedied. The suggestion has heretofore been made, that along those portions of the line, which are wooded, a clearing ten or twelve feet wide be made, and that where the woods are apt to be felled, for timber and not for cultivation, mounds or signals be erected. The carrying out of such a suggestion could only be done at a considerable cost and the benefit to be derived could only be but a temporary one.

In the immediate vicinity of each monument, trees had been hacked as witnesses; in some cases these have been cut down purposely, it seems to us, by the lumbermen, and in other cases the witness hacks have been almost obliterated by age.

We have endeavored to make the detailed description of the location of the monuments, which follows, as definite and complete as possible; the description of some has been changed to meet new conditions, and that of others has been more fully given; so that on future examinations, the time consumed should be considerably reduced, and the expenses proportionately lessened.

New monuments are required at the following places: Milestone 42; the monument now marking this point has been broken off two and one-half feet from the top.

On the D., L. & W. R. R., just east of Waverly; the monument marking this point has been broken off about one foot below the surface.

At the corner of Allegany and Steuben counties, New York; this monument has entirely disappeared.

On the Olean, Oswayo and Eastern Railroad; this road has recently been built across the line.

On the highway leading from North East to State Line; this monument has been destroyed by fire.

The following monuments should be reset: Nos. 73, 74, 100, 169, 183, 250 and 341.

CHARLES H. FLANIGAN,
For New York.

JOHN W. SCHALL,
For Pennsylvania.

Detailed Description of the Location of Monuments on the Boundary Line Between New York and Pennsylvania.

MONUMENT No. 1 — HIGHWAY No. 1.

Is a highway monument standing on the southwest side of the river road leading from Hale's Eddy to Susquehanna, on the right hand bank of the Delaware river, and about 12 feet east of the large initial monument. It is on line between properties of Elias Mereness and Day Turrell. This monument was found to be in good condition in every respect.

MONUMENT No. 2 — LARGE INITIAL MONUMENT.

Is a large block of Rhode Island granite, ten and one-half feet long, the upper six feet being dressed in the form of a flat obelisk, two and one-third feet wide and one and one-third feet thick. The words "Boundary Monument," and the date "1884" are cut on both sides. The north side is further marked:

NEW YORK.
HENRY R. PIERSON,
ELIAS W. LEAVENWORTH,
CHAUNCEY M. DEPEW,
COMMISSIONERS.

SIX HUNDRED FEET WEST OF THE NORTHEAST CORNER OF PENNSYLVANIA.
H. W. CLARK,
SURVEYOR.

The south side is further marked:

PENNSYLVANIA.
JAMES WORRALL,
CHRISTOPHER M. GERE,
ROBERT N. TORREY,
COMMISSIONERS.

SIX HUNDRED FEET WEST OF THE NORTHEAST CORNER OF PENNSYLVANIA.
C. M. GERE,
SURVEYOR.

This monument is situated about 20 feet west of the road on the right hand bank of the Delaware river. It is on line between properties of Elias Mereness and Day Turrell. This monument was found to be in good condition in every respect.

MONUMENT No. 3 — MILESTONE 1.

Is a highway monument standing 60 feet east of the road, which runs southeasterly from the bridge over the Delaware river at Hale's Eddy, on the west side of a deep ravine 240 feet west of creek, and 10 feet south of barb-wire fence, which at this point turns southerly. The woods at the west side of the road, where the line crosses, have been cleared on the south. It is on the property of J. C. Olds. This monument was found to be in good condition in every respect.

MONUMENT No. 4 — MILESTONE 2.

Is a small monument standing on level ground, about 870 feet east of monument No. 5, 10 feet north of the left hand bank of Cequaga Lake brook, 60 feet west of a maple which stands almost on line and north 46 degrees, west about 800 feet to Elisha Alexander's house. It is on the property of Elisha Alexander. This monument was found to be in good condition in every respect.

MONUMENT No. 5 — HIGHWAY STONE 1.

Is a highway monument on the west side of a highway leading from Hale's Eddy to Susquehanna, 870 feet west of monument No. 4, and about 200 feet south of Elisha Alexander's house. It is on the property of S. B. Alexander. This monument was found to be in good condition in every respect.

MONUMENT No. 6 — MILESTONE 3.

Is a small monument 21 chains west of the position of the original monument, in the west edge of thin woods, 15 feet east of a lightly traveled road and 12 paces east of a three-inch poplar, which stands on the west edge of the road and about 100 feet south of where the hill rises sharply; the ground here is thickly covered with brush. It is on the property of Harvey DeHaen. This monument was found to be in good condition in every respect.

MONUMENT No. 7 — MILESTONE 4.

Is a highway monument on the northeasterly side of a highway along the left bank of Oquaga Lake brook, leading from Sherman to Oquaga lake. It is on line between the properties of William Gunder and J. H. Pron. This monument has its southeast corner slightly chipped, otherwise it was found in good condition.

MONUMENT No. 8 — MILESTONE 5.

Is a small monument in cleared land near the top of a southeasterly slope about 800 feet north of George Lee's house, 250 feet north of a sugar maple, north 20 degrees east 58 paces of a white ash, and about 300 feet east of a small grove near the summit. It is on the property of George Lee. This monument was found to be in good condition in every respect.

MONUMENT No. 9 — HIGHWAY STONE 1.

Is a highway monument on the west side of a highway leading from Danville to Sherman, about 800 feet south of Talmadge's house and 400 feet west of Oquaga Lake dam. It is on line between the properties of Leonard Sweet and J. E. Talmadge. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 10 — MILESTONE 6.

Is a small monument in a small hollow at the foot of a steep easterly slope, 155 feet east of monument No. 11, and along the south edge of a clearing. It is on line between the properties of Thomas Arnica and Thomas Myrick. This monument was found to be in good condition in every respect.

MONUMENT No. 11 — HIGHWAY STONE 1.

Is a highway monument on the west side of the east fork of the highway leading from Danville to Stevens' Point, about 300 feet south of where road forks, and 600 feet south of Thomas Myrick's house. It is on line between properties of Thomas Myrick and John Hemingly. This monument has heaved three inches and has all its corners badly chipped.

MONUMENT No. 12 — HIGHWAY STONE 2.

Is a highway monument on the south side of boundary line road, and about 50 feet west of where it is intersected by the west fork of the highway leading from Danville to Stevens' Point. It is on line between the properties of Thomas Myrick and John Hemingly. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 13 — HIGHWAY STONE 3 AND COUNTY STONE 1.

Is a highway monument on the south side of boundary line road, near the point where the road turns to the southwest and at west end of barb wire fence. It marks the corners of Wayne and Susquehanna counties, Pennsylvania. It is on line between the properties of E. Alexander and David Dale. This monument was found to be in good condition in every respect.

MONUMENT No. 14 — MILESTONE 7.

Is a small monument near the foot of the second steep westerly slope east of Deep hollow, in land which was once cleared, alongside old log line fence, and 1,692 feet east of monument No. 15. It is on line between the properties of William Seamens and the Bishop estate. This monument was found to be in good condition in every respect.

MONUMENT No. 15 — HIGHWAY STONE 1.

Is a highway monument on the south side of a clearing, on west side of Deep Hollow road. It is on line between properties of Elias Decker and Clinton Mumford. This monument has heaved 4 inches, and leans slightly to the north, otherwise it was found to be in good condition.

MONUMENT No. 16 — MILESTONE 8.

Is a small monument on very steep westerly slope, about 3,684 feet west of monument No. 15, 200 feet west of the summit, and in a thick wood. It is a little to the east of a small clump of hemlocks, two of which were blased, north 66 degrees, east 12 feet from a hemlock, and north 36 degrees, east 20 feet to another, and on

south side of newly opened woods road which follows the line at this point from the east along the south boundary of George Kuhn's property. It is on line between the properties of ——— King and George Kuhn. This monument was found to be in good condition in every respect.

MONUMENT No. 17 — MILESTONE 9.

Is a small monument on steep easterly slope about 150 feet east of the summit, about 2,600 feet east of monument 18, and about 200 feet west of the corner of William O. Day's property, which is about 50 feet east of the bottom of a ravine. The woods here have been cleared on both sides of the line, but more on the New York than on the Pennsylvania side. It is on line between the properties of Wray Kessler and Luther Buchanan. This monument was found to be in good condition in every respect.

MONUMENT No. 18 — HIGHWAY STONE 1.

Is a highway monument on the east side of Pig-Pen run, alongside line fence, about 600 feet north of Aldrich's house. It is on line between the properties of H. Aldrich and J. Madden. This monument has its northeast and northwest corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 19 — TOWN STONE No. 1.

Is a small monument with diagonal grooves, marking the corner of the towns of Sanford and Windsor, Broome county, New York. it is situated in cleared field, on north side of line fence, and 440 feet east of monument No. 20. It is on line between properties of Patrick F. O'Rourke and H. Aldrich. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 20 — MILESTONE 10.

Is a small monument on the south side of thick woods, and just to the north of an abandoned road. It is on line between the properties of P. F. O'Rourke and H. Aldrich. This monument was found to be in good condition in every respect.

MONUMENT No. 21 — HIGHWAY STONE 1.

Is a small monument which was originally intended to mark a highway, but as the highway had never been opened, monument now stands in a very thick growth of bushes, 605 feet west of monument No. 20, and about 50 feet west of an old road which runs southeast from the clearing. It is on a line between the properties of O'Rourke and Lynes. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 22 — MILESTONE 11.

Is a small monument at the foot of a steep northwesterly slope, 1356.7 feet east of monument No. 23, in a thick open woods about 28 paces east of a 15-inch maple standing on line. It is on line between property of Charles Vermilia and Charles Plunket. This monument was found to be in good condition in every respect.

MONUMENT No. 23 — HIGHWAY STONE 1.

Is a highway monument on the west side of the east Cascade Valley road, and about 300 feet north of Vermilia's house. It is on line between the property of Charles Vermilia and Charles Plunket. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 24 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of the west Cascade Valley road, about 700 feet south of Frazier's house. It is on line between the property of Charles Vermilia and John Frazier. This monument has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 25 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the New York, Lake Erie and Western Railroad, and about 100 feet west of monument 24. This monument was found to be in good condition in every respect.

MONUMENT No. 26 — MILESTONE 12.

Is a small monument standing on the summit of the high narrow ridge between Cascade Valley and the Susquehanna river; it is about 500 feet west of stone quarry, and just about where the hill slopes to the north. It is on line between the properties of John Frazier and G. E. McCune. This monument was found to be in good condition in every respect.

MONUMENT No. 27 — HIGHWAY STONE 1.

Is a highway monument on the north side of road which leads from Windsor to Lanesboro, about 5 feet east from a large chestnut. It is on line between the property of G. E. McCune and J. F. McCune. This monument has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 28 — RAILROAD STONE 1.

Is a small monument standing three feet west of the track of the Delaware and Hudson Canal Company's Railroad, and about 200 feet southwest of C. C. Morse's house. This monument has its top flush with the surface of the roadbed, and has its north side badly broken and its south corners chipped.

MONUMENT No. 29 — RIVER STONE 1.

Is a small monument which marks the intersection of the boundary on the left hand bank of the Susquehanna river. It stands on level ground, in cleared field and about 50 feet east of the original monument which stands at the edge of the river bank. It is on line between the properties of J. F. McCune and N. F. Comfort. This monument was found to be in good condition in every respect.

MONUMENT No. 30 — RIVER STONE 2.

Is a small monument which marks the intersection of the boundary on the right hand bank of the Susquehanna river. It stands on level ground about 20 feet west of the position of the original monument, no trace of which now remains. It is on line between the properties of Herbert Beebee and George Pooler. This monument was found to be in good condition in every respect.

MONUMENT No. 31 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of the road, on the right hand bank of the Susquehanna river, about 600 feet south of Pooler's house. It is on line between the properties of Herbert Beebee and George Pooler. This monument has its northeast and southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 32 — MILESTONE 13.

Is a small monument standing in cleared land 1,698 feet west of monument No. 31, and 10 feet north of stone line fence, and 4 feet west of worm fence running northerly. It is on line between the properties of H. Beebee and George Pooler. This monument was found to be in good condition in every respect.

MONUMENT No. 33 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the Oquaga Mountain road, at the west end of a woods road, which follows the line for a short distance, on north edge of clearing, and about 500 feet north of A. G. Matthews' house. It is on line between the properties of H. Beebee and A. G. Matthews. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 34 — SECTION STONE 1.

Is a small monument with diagonal grooves, which marks the corner of Hooper patent and the third tract in Windsor. It stands on a very steep northely slope in a laurel thicket in thick woods, about 700 feet east of monument No. 35. It is on line between the properties of A. G. Matthews and the Pooler estate. This monument was found to be in good condition in every respect.

MONUMENT No. 35 — MILE STONE 14.

Is a small monument standing on northerly slope, just south of quite a steep slope to the north, in a laurel thicket in thick woods, 1,647 feet east from monument No. 36. It is on line between the properties of A. G. Matthews and C. C. Worden. This monument was found to be in good condition in every respect.

MONUMENT No. 36 — HIGHWAY STONE 1.

Is a highway monument on the southwest side of a wood road on the summit of a ridge 3,848 feet east of monument No. 38. It is on the property of Joshua Bevens. This monument was found to be in good condition in every respect.

MONUMENT No. 37 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a road leading from Hickory Grove to Windsor, about 500 feet south of Haxton's house and about 100 feet northwest of D. S. Mayo's house. It is on line between the property of Abe Haxton and Stephen Bevens. This monument was found to be in good condition in every respect.

MONUMENT No. 38 — MILESTONE 15 AND TOWN STONE.

Is a small monument with diagonal grooves standing in cleared land under a worm fence on west side of valley and about 250 feet east of the foot of a steep easterly slope and 557.5 feet west of monument No. 37. This monument marks the corner of the townships of Great Bend and Oakland, Susquehanna county, Pennsylvania. It is on line between the properties of Abe Haxton and Stephen Bevens. This monument has heaved 8 inches and leans to the east, otherwise it was found to be in good condition.

MONUMENT No. 39 — HIGHWAY STONE 1.

Is a highway monument standing on the northeast side of a road, which at this point follows the boundary line for a short distance. It is northwest from Locust Hill church and 100 feet east of small brook. It is on line between properties of Elias Eighmy and Addison Brush. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT NO. 40 — MILESTONE 16.

Is a small monument standing in a wet meadow about 250 feet west of where road leaves the boundary line and turns to the north, and 672.7 feet west of monument No. 39. It is on line between the properties of H. E. Brush and N. W. Stone. This monument has heaved 6 inches and has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 41 — HIGHWAY STONE 1.

Is a highway monument standing on east side of wood road on northeast slope near the summit of the ridge, in thick woods, 4 feet northwest of blazed maple. It is on the property of Marcus Colville. This monumen has heaved 2 inches and has its southeast corner broken and northwest corner slightly chipped, otherwise it was found in good condition.

MONUMENT No. 42 — HIGHWAY STONE 2.

Is a highway monument standing on south side of highway leading from Windsor to Great Bend. It is on the property of Marcus Colville. This monument has its south side slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 43 — MILESTONE 17.

Is a small monument standing in cleared field about forty feet from the brow, 10 feet south of line fence, and about 100 feet west from bottom of slope, and 369.8 feet east of monument No. 44. It is on line between the properties of A. Judd and Marcus Colville. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 44 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Great Bend to Windsor, on the west side of the valley and 10 feet south of line fence. It is on line between the properties of A. Judd and Marcus Colville. This monument has its northwest corner and east edge slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 45 — HIGHWAY STONE 2.

Is a highway monument standing on the east side and at the north end of a private road about 500 feet north of the Keldur house. It is on line between the property of Yeager and Keldur. This monument has heaved 3 inches and has its southwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 46 — MILESTONE 18.

Is a small monument standing in a bush lot near the southwest corner of a piece of woods, west side of a rocky summit near the brow of a high steep northwesterly slope, overlooking the valley of the east branch of Trowbridge creek. It is on line between the properties of G. Andrews and Casey Keldur. This monument has its west edge slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 47 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the highway which follows the east branch of Trowbridge creek, and about 300 feet southwest of B. J. Roosa's house. It is on line between the properties of B. J. Roosa and F. Millard. This monument was found to be in good condition in every respect.

MONUMENT No. 48 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of the main road leading from Great Bend to Windsor at its junction with road running easterly. It is on line between the property of Amos Frank and Frank Millard. This monument was found to be in good condition in every respect.

MONUMENT No. 49 — MILESTONE 19.

Is a small monument standing on a very steep easterly slope in thick woods, 465 feet west of Trowbridge creek, 15 feet southwest of a 15-inch maple, and 5 feet northeast of 6-inch maple, and 165 feet east of "Fantail Corner," which is a rough monument of native rock 16 inches high, 10 inches wide and 4 inches thick, marking the corner of six Pennsylvania subdivisions. It is on line between the properties of Squire and Flynn. This monument was found to be in good condition in every respect.

MONUMENT No. 50 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a private road, 75 feet south of Flynn's house, and 250 feet east of a large barn. It is on line between the properties of Squire and Flynn. This monument has heaved 2 inches and has all its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 51 — TOWN STONE 1.

Is a small monument with diagonal grooves marking the corner of the towns of Kirkwood and Windsor, in Broome county, New York. It stands in cleared field 442.4 feet west of monument No. 50, and 95.9 feet southwesterly from the southwest corner of Squire's large barn. It is on line between the properties of Squire and Flynn. This monument was found to be in good condition in every respect.

MONUMENT No. 52 — MILESTONE 20.

Is a small monument standing upon the Susquehanna river flats 654.4 feet east of monument No. 53, and just south of a wire fence. It is on line between the properties of Sollen Finn and G. S. Wilcox. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 53 — HIGHWAY STONE 1.

Is a highway monument standing on east side of river road on right hand bank of Susquehanna river. It is 256.3 feet south and 142.3 feet east of the center of astronomical station, which is marked by a granite monument buried 2½ feet under ground, 97.6 feet northwesterly from the northwesterly corner of the foundation of the main part of Sollen Finn's house. It is on line between the property of Sollen Finn and G. S. Wilcox. This monument was found to be in good condition in every respect.

MONUMENT No. 54 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the New York, Lake Erie and Western Railroad. This monument has its top buried 12 inches below the surface of the roadbed, and its corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 55 — MILESTONE 20 3-8.

Is a small monument standing on the east side of the base of the first latitude stone on river flats, 20 feet east of the right hand bank of the river, and 60 feet west of a hickory tree. It is on line between the property of John Clyne and G. S. Wilcox. This monument was found to be in good condition in every respect.

MONUMENT No. 56 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the Delaware, Lackawanna and Western Railroad and about 200 feet east of monument No. 37. It is badly broken on all sides, otherwise it was found to be in good condition.

MONUMENT No. 57 — HIGHWAY STONE 2.

Is a highway monument standing on west side of river road on left hand bank of Susquehanna river about 150 feet north of Henry Forboss' house. It is on line between the property of Henry Forboss and William Schnediker. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 58 — MILESTONE 21 AND TOWN STONE.

Is a small monument with diagonal grooves, standing at the north end of the summit of the high ridge between the Susquehanna river and Snake creek. It is in thick woods, 20 feet southeast of an 18-inch chestnut. It marks the corner of the towns of Great Bend and Liberty, Susquehanna county, Pennsylvania. It is on line between the property of Henry Forboss and William Schnediker. This monument was found to be in good condition in every respect.

MONUMENT No. 59 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, which is now but little used, about 600 feet east of Snake creek. It is on line between the property of Daniel English and Fish. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 60 — MILESTONE 22.

Is a highway monument standing on the west side of the Montrose and Binghamton turnpike, and about 300 feet north of Sullivan's house. It is on line between the property of Chalker and Sullivan. This monument has heaved 2 inches, and has its northeast and southwest corners badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 61 — MILESTONE 23.

Is a small monument standing in a cleared field on a gentle southerly slope 300 feet north of a creek, which runs southeasterly, and 15 feet east of the east end of line barb wire fence, and fence running northerly. It is on property of Frederick Kaufman. This monument has heaved 5 inches, otherwise it was found in good condition.

MONUMENT No. 62 — MILESTONE 24.

Is a small monument standing in a cleared field in a shallow gully, 329.7 feet east of monument No. 63, and 20 feet south of a worm fence. It is on the property of Charles Adams. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 63 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Brookdale to Conkling's forks, about 800 feet north of Adams' house. It is on the property of Charles Adams. This monument was found to be in good condition in every respect.

MONUMENT No. 64 — MILESTONE 25.

Is a small monument standing on the west edge of a swamp and on the east edge of a small grove, 20 feet north of barb wire fence and about 1,000 feet northerly from Wilbur's house. It is on line between the properties of Eugene Wilbur and F. J. Fish. This monument was found to be in good condition in every respect.

MONUMENT No. 65 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Brookdale to Binghamton, about 15 feet north of line fence. It is on line between the properties of Eugene Wilbur and T. J. Fish. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 66 — MILESTONE 26.

Is a small monument standing in thick woods, about 90 feet west of west end of short piece of line fence, north of clearing and just

below the top of a steep slope, and about 300 feet north of the bottom of a deep hollow in the road, which runs nearly parallel with the line, 398 feet west of the southeast corner of the town of Binghamton. It is on line between the properties of T. J. Fish and George Buchanan. This monument was found to be in good condition.

MONUMENT No. 67 — HIGHWAY STONE 1.

Is a highway monument standing on south side of boundary line road, and just where road turns to northeast on south side of worm fence. It is on line between the property of J. Conte and Alpheus Whipple. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 68 — MILESTONE 27 AND TOWN STONE.

Is a small monument with diagonal grooves, standing on south side of boundary line road under worm fence, and 197 feet west of monument No. 67. It marks the corners of the townships of Liberty and Silver Lake in Susquehanna county, Pennsylvanina. It is on line between the property of J. Conte and Alpheus Whipple. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 69 — HIGHWAY STONE 1.

Is a highway monument standing at the west end of boundary line road, 300 feet north of creek and 250 feet north of Coyle's house. It is on line between the property of Peter Brady and Michael Coyle. This monument was found to be in good condition in every respect.

MONUMENT No. 70 — MILESTONE 28.

Is a highway monument standing about 20 feet west of the west edge of a highway leading northerly to Binghamton, in the corner of line fence. It is on line between the property of James Chapman and Thomas Monihan. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 71 — MILESTONE 29.

Is a small monument standing in cleared land, 1,415 feet east of monument No. 72, upon westerly slope, 100 feet west of the summit and 3 feet north of an old stone wall. It is on line between the property of B. Gagen and Thomas Gagen. This monument was found to be in good condition.

MONUMENT No. 72 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Brackney to Hawleytown, 125 feet southwesterly from Thomas Gagen's house, and 1,415 feet west of monument No. 71. It is on line between the property of T. Wilcox and Isaac Gage. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 73 — MILESTONE 30.

Is a small monument standing in cleared pasture land, 75 feet west of brook, 9 feet south of an old line stone fence and 875.6 feet east of monument No. 74. It is on the property of T. Monihan. This monument was found to have heaved 10 inches, otherwise it was found to be in good condition.

MONUMENT No. 74 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of Silver Lake road near the northwest corner of an old stone foundation, and about 250 feet south of blacksmith shop standing in forks of road. It is on the property of Thomas Monihan. This monument has heaved 8 inches, otherwise it was found to be in good condition.

MONUMENT No. 75 — HIGHWAY STONE 2.

Is a highway monument standing on the south side of boundary line road, and at the point where it turns to the northeast. It is on line between the property of Michael Cannon and Frank Cameron. This monument has its sides chipped, otherwise it was found to be in good condition.

MONUMENT No. 76 — MILESTONE 31.

Is a highway monument standing on south side of boundary line road, and close to fence, 124 feet east of where brook crosses the

road. It is on the property of William Laffey. This monument was found to be in good condition in every respect.

MONUMENT No. 77 — MILESTONE 32 AND TOWN STONE.

Is a small monument with diagonal grooves, standing on the west side of the summit of the high ridge, east of Choconut valley, about 75 feet west of summit, on gentle westerly slope, and about 50 feet north of where east end of fence turns to the south. It is on line between the property of William Clarke and Samuel Lee. This monument has its corners chipped, otherwise it was found to be in good condition. This monument marks the corner of the towns of Silver Lake and Choconut, Susquehanna county, Pennsylvania.

MONUMENT No. 78 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of Choconut creek road, about 400 feet north of John Hinckey's house. It is on line between the property of John Hinckey and Ambrose Lathrope. This monument was found to be in good condition in every respect.

MONUMENT No. 79 — MILESTONE 33.

Is a small monument standing on the easterly side of the mountain west of the Choconut creek valley, 935 feet west of creek and under " line " fence. It is on line between the property of Michael McGraw and F. Powell. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 80 — MILESTONE 34.

Is a small monument standing on rough easterly slope, covered with burnt woods, about 80 feet west of west branch of small creek and about 600 feet east of summit. It is on line between the property of John Dean and John Schnediker. This monument was found to be in good condition in every respect.

MONUMENT No. 81 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway running northerly and southerly, and just where it turns to the east. It is on the property of Joshua Underwood. This monument was found to be in good condition in every respect.

MONUMENT No. 82 — MILESTONE 35.

Is a small monument standing in a cleared field at the top of a steep bluff sloping southeasterly in corner of worm fence and on the west side of the road leading to Thomas Dean's residence. It is on line between the property of Waffles and Dean. This monument was found to be in good condition in every respect.

MONUMENT No. 83 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a private road which runs southerly from Tracey creek road, and about 800 feet southwesterly from Eggleston's residence and alongside line fence. It is on line between the property of Eggleston and Weed. This monument has heaved two inches, has its east side broken and all corners chipped.

MONUMENT No. 84 — MILESTONE 36.

Is a small monument standing in an extensive briar patch on level ground, 309 feet west of monument No. 83 and 4 feet north of line fence. It is on line between the property of Eggleston and Weed. This monument was found to be in good condition in every respect.

MONUMENT No. 85 — MILESTONE 37.

Is a small monument standing on a westerly slope in south edge of thick woods, 300 feet east of a deep ravine and 1,028 feet east of monument No. 86. It is on line between the property of Jinks and Crimmins. This monument was found to be in good condition in every respect.

MONUMENT No. 86 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Little Meadows to Apalachin, about 900 feet north of Crimmins's residence. It is on line between the property of Jinks and Crimmins. This monument was found to be in good condition in every respect.

MONUMENT No. 87 — COUNTY STONE 1.

Is a small monument with diagonal grooves, marking the corner of Broome and Tioga counties, New York. It stands on a gentle westerly slope 809.6 feet east of monument No. 88, and about 1,600

feet west of summit of ridge in an open field under a stump fence running north and south, about 6 feet south of line fence and about forty feet south of large stone pile. It is on line between the property of Jinks and Borden. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 88 — MILESTONE 38.

Is a small monument standing on westerly slope on the east side of an abandoned wood road and near northeast corner of a clearing 809.6 feet west of monument No. 87, and 5 feet north of line fence. It is on line between the property of Jinks and Borden. This monument was found to be in good condition in every respect.

MONUMENT No. 89 — HIGHWAY STONE 1.

Is a highway monument standing at the east end of road, northeast of the village of Little Meadows, about 100 feet east of Bowden's line, and 56 paces east of the southeast corner of Bowden's barn. It is on line between the property of Bowden and Borden. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 90 — MILESTONE 39.

Is a highway monument standing on the south side of fence on south side of boundary line road opposite the residence of Albert Card and 40 feet west of where boundary line is crossed by Jones' creek. It is on line between the property of Albert Card and S. A. Pitchard. This monument was found to be in good condition in every respect.

MONUMENT No. 91 — HIGHWAY STONE 1.

Is a highway monument standing on north side of boundary line road and about 75 feet east of where it forks. It is on line between the property of Duell and Pitchard. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 92 — MILESTONE 39½.

Is a small monument standing on westerly slope on south side of board fence. It is in the meridian of astronomical station, Little

Meadows, 2.41 feet south of the center of the station, and about 75 feet east of Jones' creek. It is on line between the property of Duell and Pitchard. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 93 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Little Meadows to Apalachin, opposite the residence of D. Holland. It is on the property of John Giles. This monument has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 94 — MILESTONE 40 AND COUNTY STONE 1.

Is a small monument with diagonal grooves, standing on a steep northerly slope, in the northeast corner of a piece of woods just west of the summit of the north end of the ridge west of Apalachin creek and at the west end of a line fence. It marks the corner of Susquehanna and Bradford counties, Pennsylvania. It is on line between the property of Hall and Holland. This monument was found to be in good condition in every respect.

MONUMENT No. 95 — HIGHWAY STONE 1

Is a highway monument standing on the northwest side of a highway 1,000 feet north of Mayhew's house. It is on line between the property of P. Mayhew and Phoebe Stockwell. This monument was found to be in good condition in every respect.

MONUMENT No. 96 — MILETSONE 41.

Is a small monument standing in a cove on the north side of a ridge near the foot of a steep northerly slope at the northeast corner of a clearing and 6 feet south of an old stone wall. It is on line between the property of Noteman and Keeler. This monument was found to be in good condition in every respect.

MONUMENT No. 97 — MILESTONE 42.

Is a small monument standing on level ground, 1,150 feet east of the summit of a ridge and about 1,448 feet east of monument No. 98, and just to the north of line fence. It is on line between the

property of Alexander Giles and Clarence Corbin. This monument was found to have been broken off 2½ feet from the top.

MONUMENT No. 98 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading to Owego, at the northeast corner of an apple orchard and 400 feet south of Alexander Giles' house. It is on line between the property of Alexander Giles and Clarence Corbin. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 99 — MILESTONE 43.

Is a highway monument standing on the west side of Owego and Milford turnpike, at its intersection with Prince's Hollow road. It is on line between the property of Harrington and Colburn. This monument was found to be in good condition in every respect.

MONUMENT No. 100 — MILESTONE 44.

Is a highway monument standing on a steep easterly slope 120 feet west of brook, 15 feet east of road and 2 feet north of line fence. It is on the property of A. R. Gifford. This monument has heaved 9 inches, otherwise it was found to be in good condition.

MONUMENT No. 101 — MILESTONE 45.

Is a highway monument standing on west side of road leading from Cadiz postoffice to Montrose turnpike on top of summit of ridge overlooking the valley of Babcock creek, about 500 feet north of Holmes' house and near the most southerly of four small maples standing on the west side of the road. It is on property of Thomas Holmes. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 102 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the road which follows the valley of Babcock creek. It is on line between the property of Ore Brown and F. C. Waite. This monument has its northeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 103 — MILESTONE 46, TOWN STONE 1.

Is a highway monument standing on the west side of a highway leading from Waite's settlement to Owego, and just south of a sluiceway which crosses the road; it marks the corner of the townships of Warren and Windham, Bradford county, Pennsylvania. It is on line between the property of Mrs. A. Brown and Amos Condon. This monument has heaved 2 inches and has its east corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 104 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading to Owego, about 200 feet north of the summit of a ridge. It is on line between the property of Mrs. A. Brown and Amos Condon. This monument was found to be in good condition in every respect.

MONUMENT No. 105 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a highway leading from Cliff Market to Owego, about 200 feet south of Walter Cliff's house, and just where road turns sharply. It is on line between the property of Jerry Waite and Anson White. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 106 — MILESTONE 47.

Is a small monument standing in an open field on level ground just south of line fence, 3 paces east of fence running southerly and 660 feet west of monument No. 105. It is on line between the property of Jerry Waite and Anson White. This monument was found to be in good condition in every respect.

MONUMENT No. 107 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway on steep easterly slope, and about 150 feet northeast of Waite's barn. It is on property of George Waite. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 108 — MILESTONE 48.

Is a small monument standing on an easterly slope in partial clearing in thick brush, about 125 feet east of woods, about 200 feet west of Walter Tripp's house, 175 feet west of brook and 2,356 feet east of monument No. 109. It is on line between the property of Fred Olmstead and Thomas Lynch. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 109 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Linden to Waverly, about 300 feet north of Olmstead's house. It is on line between the property of Fred Olmstead and Thomas Lynch. This monument was found to be in good condition in every respect.

MONUMENT No. 110 — MILESTONE 49.

Is a small monument standing about 3,020 feet west of monument No. 109, in thick woods, at the northeasterly edge of the level summit of the ridge east of Wappasening valley, about 400 feet west of clearing, 6 paces north of woods road, 3 paces east of large chestnut. It is on line between the property of James Olmstead and Isaiah Reynolds. This monument was found to be in good condition in every respect.

MONUMENT No. 111 — MILESTONE 50.

Is a highway monument standing on the south side of boundary line road, close to a stone wall, and about 90 feet south of a barn. It is on line between the property of James Morey and Robert Howell. This monument was found to be in good condition in every respect.

MONUMENT No. 112 — HIGHWAY STONE 1.

Is a highway monument standing on south side of boundary line road at its junction with road leading south of Raysville. It is on line between the property of James Morey and Robert Howell. This monument was found to be in good condition in every respect.

MONUMENT No. 113 — HIGHWAY STONE 2.

Is a highway monument standing on the north side of boundary line road at junction with road running north along the east bank of Wappasening creek and about 75 feet southwest of J. H. Morey's house. It is on line between the property of James Morey and Robert Howell. This monument has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 114 — MILESTONE 51.

Is a small monument standing on the easterly slope of the ridge west of Wappasening valley, 2,000 feet east of the summit, on the south edge of woods, and about 600 feet north of a road which runs parallel with the boundary line towards the west, and at this point turns to the south, and just north of line fence. It is on line between the property of Frank Briggs and Clinton Johnson. This monument was found to be in good condition in every respect.

MONUMENT No. 115 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, leading from Nichols to Rome, and about 300 feet north of Barnes' residence. This monument has its northwest and southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 116 — MILESTONE 52 AND TOWN STONE 1.

Is a small monument, with diagonal grooves, standing about half way up the low bluff, east of Little Wappasening creek, 67.75 feet east of monument No. 117. It marks the corner of the townships of Windham and Litchfield, Bradford county, Pennsylvania. It is on line between the property of Scott Bennett and Johnson Rogers. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 117 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the road running along the west bank of Little Wappasening creek and about 50 feet northeast of Johnson Rogers' house. It is on line between the property of Scott Bennett and Johnson Rogers. This monument has its top 2 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 118 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of the road, which follows the left bank of Little Wappasening creek northerly into Nichols, and about 300 feet northeast of Mrs. Lee's house. It is on line between the property of Mrs. Lee and Johnson Rogers. This monument has its corners broken, otherwise it was found to be in good condition.

MONUMENT No. 119 — MILESTONE 53.

Is a small monument standing under a stump fence in cleared land, upon high ground, which is nearly level, and northwest of the west branch of Little Wappasening creek, 3,302 feet east of monument No. 120. It is on line between the property of Platt Hunt and Zind Goodsell. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 120 — HIGHWAY STONE 1.

Is a highway monument standing at the east end of an abandoned boundary line road and on its south side, 6 feet north of stump fence. This monument was found to be in good condition in every respect.

MONUMENT No. 121 — MILESTONE 54.

Is a highway monument standing on the south side of an abandoned boundary line road, at the north end of stone fence. It is on the property of C. Ellis. This monument has heaved 7 inches, leans slightly to the north and has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 122 — HIGHWAY STONE 1.

Is a highway monument standing at the west end of boundary line road, at its junction with a road running northerly and southerly, 640 feet west of monument No. 121. It is on property of C. Ellis. This monument was found to be in good condition in every respect.

MONUMENT No. 123 — MILESTONE 55.

Is a small monument standing upon a southerly slope, under fence, about 90 feet southwest of barn, and about 100 feet east of the point at which a short piece of the boundary line road turns toward the northeast. It is on line between the property of A. D. Chandler and George Stauff. This monument was found to be in good condition, in every respect.

MONUMENT No. 124 — HIGHWAY STONE 1.

Is a highway monument standing at the west end of a short piece of boundary line road, just where it turns to the southwest, about 300 feet west of George Stauff's house. It is on line between the property of A. D. Chandler and George Stauff. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 126 — HIGHWAY STONE 2.

Is a small monument standing in a cleared field on the summit of a high ridge overlooking the Susquehanna valley, 15 feet north of line fence. It is on the property of A. Parks. This monument has its north side and east side bady chipped and has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 126 — HIGHWAY STONE 3.

Is a highway monument standing at the east end of boundary line road about where it turns southeasterly, about 90 feet northeasterly of the northeast corner of the porch of Parks' residence, and about 28 feet west of Parks' carriagehouse. It is on the property of A. Parks. This monument was found to be in good condition in every respect.

MONUMENT No. 127 — MILESTONE 56.

Is a small monument standing a little to the north of the center of the road, which follows the boundary line. It is 12.75 feet south of line fence on north side of the road, north 60 degrees, west 49.5 feet from the most westerly of three apple trees of about twenty years' growth, standing on the south side of a road, and north 70 degrees, east 46.9 feet of an apple tree of about five years' growth,

1,090 feet east of monument No. 128 and 348.25 feet west of monument No. 126. It is on the property of A. Parks. This monument has its top 3 inches below the surface of the road, and has its south end broken, otherwise it was found to be in good condition.

MONUMENT No. 128 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the river road on the left hand bank of the Susquehanna river, in front of a cemetery and at the west end of boundary line road. It is on the property of A. Parks. This monument was found to be in good condition in every respect.

MONUMENT No. 129 — RIVER STONE 1.

Is a small monument standing on the river flats about thirty feet east of the left hand bank of the Susquehanna river, in cleared field and under a barb wire fence. It is on line between the property of Mercum Parks and Albrans Parks. This monument has its north side chipped, otherwise it was found to be in good condition.

MONUMENT No. 130 — RIVER STONE 2.

Is a small monument standing on high ground, about 50 feet west of the right-hand bank of the Susquehanna river, a little to the west of the north end of river road, about 50 feet north of Silas Cook's house, and 4 feet south of line fence. It is on line between the property of Hill and Cook. This monument was found to be in good condition in every respect.

MONUMENT No. 131 — MILESTONE 57.

Is a small monument standing in a cleared field on rolling ground close to the north side of line fence, about 2,175 feet west of monument No. 130, and 60 feet west of 18-inch oak standing on line. It is on line between the property of Hill and Wolcott. This monument was found to be in good condition in every respect.

MONUMENT No. 132 — RAILROAD STONE 1.

Is a small monument standing three feet east of the Southern Central railroad track on south edge of clearing. This monument has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 133 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Ellison to Waverly, 15 feet north of line fence. It is on line between the property of Woodruff and Wilkinson. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 134 — MILESTONE 58.

Is a small monument standing upon the steep west slope of a narrow gravel ridge in cleared field, about 1,550 feet east of monument No. 135, 30 feet east of a wild cherry, standing on north side of line fence, and 165 feet east of a rough stone monument, with a cross upon its top, which marks the corner of the subdivision of the Douglass military patent. It is on line between the property of Woodruff and Wilkinson. This monument was found to be in good condition in every respect.

MONUMENT No. 135 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Sayre to Owego, 15 feet west of sluiceway. It is on line between the property of J. Bonnell and Charles Smith. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 136 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the Delaware, Lackawanna and Western railroad, on a high embankment about 400 feet west of a cut, and slightly east of a small creek running northerly and southerly. This monument is broken off one foot from the top.

MONUMENT No. 137 — MILESTONE 59.

Is a small monument standing in an open, cultivated field, about 100 feet north of the high embankment of the Delaware, Lackawanna and Western railroad, and about 70 feet east of the Geneva, Ithaca and Sayre railroad. This monument has its northeast and southeast corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 138 — RAILROAD STONE 1.

Is a small monument standing between the two easterly tracks of the Geneva, Ithaca and Sayre railroad, and about 150 feet north of the Delaware, Lackawanna and Western railroad crossing. This monument has its north side slightly chipped and its top flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 139 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of Spring street, in the village of Sayre, along the east side of a board walk, 30 feet south of Connell's grocery store. It is on the property of Connell. This monument has its southwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 140 — RAILROAD STONE 2.

Is a small monument standing between the two main tracks of the Lehigh Valley railroad, and about 800 feet north of the Delaware, Lackawanna and Western railroad crossing, and 71 paces north of watering pipe. This monument has heaved two inches and has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 141 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of Wilcox avenue, in the village of Waverly, about 150 feet south of Doyle street, and 10 feet west of fence. It is on line between the property of Frank Hart and Mrs. McCarthy. This monument has all its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 142 — HIGHWAY STONE 3.

Is a highway monument standing on the west side of Henry street, in the village of Waverly, about 200 feet south of Erie street and 10 feet east of fence. It is on the property of Mrs. Noonan. This monument has its east side slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 143 — HIGHWAY STONE 4.

Is a highway monument standing on the west side of Pennsylvania avenue, in the village of Waverly, 150 feet south of bridge over the Erie railroad tracks and 10 feet east of fence. It is on the property of P. R. Atley. This monument was found to be in good condition in every respect.

MONUMENT No. 144 — MILESTONE 60.

Is a small monument standing in the rear end of a garden, which fronts north on Railroad avenue, in the village of Waverly, about 210 feet east of Fulton street. It is on the property of Mrs. Kinney. This monument was found to be in good condition in every respect.

MONUMENT No. 145 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of Fulton street, in the village of Waverly, 150 feet south of the Erie railroad tracks, 10 feet west of the southeast corner of Genung's sash and blind factory. It is on the property of Genung. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 146 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of Loder street, in the village of Waverly, 15 feet west of the Erie House and 100 feet south of the Erie railroad. This monument has its edges slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 147 — HIGHWAY STONE 3.

Is a highway monument standing on the top of cut of the Erie railroad, at south end, and 5 feet east of bridge crossing Chemung street, in the village of Waverly, and near a P. C. It is on the property of the Erie railroad. This monument has its corners and edges chipped, otherwise it was found in good condition.

MONUMENT No. 148 — HIGHWAY STONE 4.

Is a highway monument standing on the south side of Bradford street in the village of Waverly, just south of wire fence and about

390 feet east of monument No. 149. It is on line between the property of the Erie railroad and the Delaware, Lackawanna and Western railroad. This monument was found to be in good condition in every respect.

MONUMENT No. 149 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the Delaware, Lackawanna and Western railroad, about 60 feet northwest from the northwest corner of Gaff's icehouse. This monument has heaved 4 inches and is badly broken.

MONUMENT No. 150 — SPANISH HILLS MONUMENT.

Is a highway monument standing on a small knoll, extending northerly from the Spanish Hills, 60 feet south of cut on Delaware, Lackawanna and Western railroad, and 15 feet east of the old Spanish Hills monument, which is set at 60 3-4 miles. It is on the property of the Delaware, Lackawanna and Western railroad. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 151 — MILESTONE 60 7-8.

Is a small monument standing upon the river flats about 50 feet south of the high embankment of the Delaware, Lackawanna and Western railroad, at the east end of the river bridge, and about 25 feet east of the left hand bank of the Chemung river. It is on the property of the Delaware, Lackawanna and Western railroad. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 152 — MILESTONE 61.

Is a small monument standing on the right hand bank of the Chemung river, at the foot of the slope of a high embankment of the Delaware, Lackawanna and Western railroad. It is buried under a pile of loose rock, which has been used to strengthen the embankment. It is 21.1 feet south of the west abutment of the Delaware, Lackawanna and Western railroad bridge, and in line with a point 6 inches east of the face of the abutment above the bridge seat. This monument was found to be in good condition in every respect.

MONUMENT No. 153 — RAILROAD STONE 1.

Is a small monument standing between two tracks of the Delaware, Lackawanna and Western railroad, on the high embankment west of the Chemung river, 294.9 feet west of the face of west abutment of river bridge. This monument was found to be in good condition in every respect.

MONUMENT No. 154 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading westerly from the village of Waverly, about 300 feet north of the Delaware, Lackawanna and Western railroad, in corner of fence. It is on the property of the Delaware, Lackawanna and Western railroad. This monument was found to be in good condition.

MONUMENT No. 155 — MILESTONE 62.

Is a small monument standing on level ground, north side of a thick growth of bushes, under line fence, 2,335 feet east of monument No. 156. It is on line between the property of Olmstead and Rogers. This monument has its southeast corner broken, otherwise it was found to be in good condition.

MONUMENT No. 156 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from the village of Waverly to Willawanna, just where road turns sharply to the south. It is on line between the property of Olmstead and Rogers. This monument was found to be in good condition in every respect.

MONUMENT No. 157 — RIVER STONE 1.

Is a small monument standing on the right hand bank of the second intersection of the Chemung river, about 50 feet east of river and under a line fence. It is on line between the property of Olmstead and Shepard. This monument was found to be in good condition in every respect.

MONUMENT No. 158 — MILESTONE 63.

Is a highway monument standing on the east side of private road, about 500 feet south of Wynkoop creek and about 950 feet

west of the left-hand bank of the Chemung river and under line fence. It is on the property of Shepard. This monument was found to be in good condition in every respect.

MONUMENT No. 159 — MILESTONE 64.

Is a small monument standing on level ground in cleared land, 4 feet south of a stone wall and about 704 feet east of monument No. 160. It is on the property of William Hulbert. This monument was found to be in good condition in every respect.

MONUMENT No. 160 — HIGHWAY STONE 1.

Is a highway monument on the west side of a road leading southerly from the village of Chemung, about 30 feet west of an apple tree, which stands alongside the fence on the east side of the road, about 250 feet northwest from Hulbert's house. It is on line between the property of J. R. Hulbert and H. Baker. This monument was found to be in good condition in every respect.

MONUMENT No. 161 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of river road, leading from the village of Chemung to Willawanna, about 100 feet southeasterly from Purcell's house. It is on a line between the property of Sarah McDuff and A. Purcell. This monument was found to be in good condition in every respect.

MONUMENT No. 162 — MILESTONE 65, TOWN STONE 1.

Is a small monument with diagonal grooves, standing in cultivated ground, under line fence, about one-fourth of a mile west of monument No. 161. It marks the corner of the townships of Athens and Ridgebury, Bradford county, Pennsylvania. It is on line between the property of Sarah McDuff and A. Purcell. This monument was found to be in good condition in every respect.

MONUMENT No. 163 — RAILROAD STONE 1.

Is a small monument standing between the two tracks of the Delaware, Lackawanna and Western railroad. This monument has its top buried 5 inches beneath the surface of the roadbed, its four corners chipped, and leans to the south, otherwise it was found to be in good condition.

MONUMENT No. 164 — MILESTONE 66.

Is a small monument standing in a thick woods, on a steep northeasterly slope, about 396 feet east of the northeast corner of a small clearing east of the summit of a ridge. It is on line between the property of Davidson and Herrick. This monument was found to be in good condition in every respect.

MONUMENT No. 165 — HIGHWAY STONE 1.

Is a highway monument standing on southeast side of a road which is now but little used, and at the northeast corner of a worm fence. It is on line between the property of Davidson and Herrick. This monument has its edges slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 166 — MILESTONE 67.

Is a small monument standing in thick woods, upon a northwesterly slope, about 250 feet west of an abandoned wood road and a brook in a deep ravine. It is on line between the property of A. C. Hillman and Richard Colville. This monument was found to be in good condition in every respect.

MONUMENT No. 167 — HIGHWAY STONE 1.

Is a highway monument standing in the center of a road running southwesterly, and just where it turns sharply to the south. It is on line between the property of James Burke and Mrs. Cassidy. This monument was found to be in good condition in every respect.

MONUMENT No. 168 — MILESTONE 68.

Is a small monument standing about 200 feet west of the summit of the ridge, on the south edge of thick, young woods, in the northeast corner of a bush lot, at the east end of a worm line fence, and at the northeast corner of Rayner's farm. It is on line between the property of Rayner and Burke. This monument was found to be in good condition in every respect.

MONUMENT No. 169 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of the road leading southerly from Wellsburg, on southwest slope. It is on

line between the property of Daniel Caldwell and John O'Brien This monument was found to have heaved 5 inches, and stands very loosely, otherwise it was found to be in good condition.

MONUMENT No. 170 — MILESTONE 69.

Is a small monument standing in thick woods, on a steep northeasterly slope, about 635 feet west of a brook, in deep ravine. It is on line between the property of Daniel Caldwell and Samuel Caldwell. This monument was found to be in good condition in every respect.

MONUMENT No. 171 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of the Bentley creek road, on a steep westerly slope and at south edge of a clearing. It is on line between the property of Joseph Prescott and David Burt. This monument was found to be in good condition in every respect.

MONUMENT No. 172 — HIGHWAY STONE 2.

Is a highway monument standing on the east edge of a highway leading from Wellsburg to Troy, along the west edge of Bentley creek, about in front of the residence of Lyman Dewey. It is on the property of Lyman Dewey. This monument was found to be in good condition in every respect.

MONUMENT No. 173 — MILESTONE 70.

Is a small monument standing in an open field, high up on a steep easterly slope overlooking the valley of Bentley creek, 279 feet east of monument No. 174. It is on property of Lyman Dewey. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 174 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a steep road near the summit of a high ridge west of the valley of Bentley creek. It is on line between the property of Ellsworthy and Arnot. This monument was found to be in good condition in every respect.

MONUMENT No. 175 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a road which, at this point, runs southwesterly. It is on line between the property of Wellsbury and Arnot. This monument has its edges slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 176 — HIGHWAY STONE 3.

Is a highway monument standing on the east side of a road, and about 800 feet north of Coleman's house. It is on line between the property of Coleman and Elliott. This monument was found to be in good condition in every respect.

MONUMENT No. 177 — MILESTONE 71.

Is a small monument standing in cleared land on a gentle southerly slope, just south of the corner of stump fence, close beside a small hickory tree, and 1,175 feet west of monument No. 176. It is on line between the property of Charles Coleman and Richard Coleman. This monument was found to be in good condition in every respect.

MONUMENT No. 178 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, running southerly and about 450 feet south of a road, which up to this point parallels the boundary line for about three-quarters of a mile from the east. It is on line between the property of James Suffern and Gilbert Coleman. This monument was found to be in good condition in every respect.

MONUMENT No. 179 — MILESTONE 72.

Is a small monument standing in a gap in a stone wall, south side of a piece of woods, north side of a lane on a steep northwesterly slope, about 50 paces west of board fence running southerly, and about 800 feet west of the summit of the ridge east of South creek. It is on the property of James Suffern. This monument was found to be in good condition in every respect.

MONUMENT No. 180 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of the main road leading from Fassett to Elmira, and 60 feet northeast of Kretty's residence. It is on the property of James Suffern. This monument has heaved 2 inches and is slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 181 — RAILROAD STONE 1.

Is a small monument standing on the west side of the Northern Central railroad track, about 16 feet west of west rail. This monument is badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 182 — MILESTONE 73.

Is a small monument standing at the east edge of a summit of the high steep ridge, west of South creek valley, 1,650 feet west of creek, and at south end of barb wire fence, which runs along the east edge of summit of ridge. It is on line between the property of Costello and Miles Rouskey. This monument was found to be in good condition in every respect.

MONUMENT No. 183 — MILESTONE 74.

Is a small monument standing in a narrow place in a swamp, in a deep valley in cleared land, about 15 feet west of brook, under a stump fence and about 1,180 feet east of the east end of boundary line road. It is on line between the property of Ira Woods and Mrs. Ray Managon. This monument has heaved 12 inches, otherwise it was found to be in good condition.

MONUMENT No. 184 — HIGHWAY STONE 1.

Is a highway monument standing at the east end of boundary line road on the north side under stump fence, and 1,180 feet west of monument No. 183. It is on line between the property of Joshua Shearer and James Hune. This monument has heaved 6 inches and has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 185 — HIGHWAY STONE 2.

Is a highway monument standing on north side of boundary line road at its junction with road running northerly to Elmira. It is on line between the property of Shearer and Brewer. This monument has its northeast and southeast corners and edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 186—MILESTONE 75 AND TOWN STONE 1.

Is a highway monument standing on the north side of boundary line road on left bank of ravine, 33 feet west of the original milestone which is at the bottom of a ravine close to the north side of road embankment. This monument is the most northerly one on the boundary. Its variation, from the astronomical parallel of 42 degrees, is 960 feet north. The original milestone marks the corner of the townships of South creek and Wells, Bradford county, Pennsylvania. It is on the property of Benjamin Seitzer. This monument was found to be in good condition in every respect.

MONUMENT No. 187 — HIGHWAY STONE 1.

Is a high monument standing at the west end of boundary line road. It is on line between the property of A. D. Griswold and Benjamin Seitzer. This monument has heaved 3 inches, and has all corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 188 — MILESTONE 76.

Is a small monument standing on a westerly slope in cleared field about 700 feet west of the summit and 15 feet south of worm fence. It is on line between the property of Palmer and Eaton. This monument has heaved 8 inches, otherwise it was found to be in good condition.

MONUMENT No. 189 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of Bird creek road, 125 feet south of where brook crosses road, and about 100 feet north of Smith's house. It is on line between the property of Mrs. Smith and Cowe. This monument has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 190 — MILESTONE 77.

It a small monument standing in cleared level land, in bottom of Bird creek valley, 204.5 feet west of monument No. 189, and about 20 feet south of line fence. It is on the property of Mrs. Smith. This monument was found to be in good condition in every respect.

MONUMENT No. 191 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the Nichols' road 4 feet north of stone wall. It is on line between the property of Norman Davy and Columbus Nichols. This monument was found to be in good condition in every respect.

MONUMENT No. 192 — MILESTONE 78.

Is a small monument standing in a small hollow, in cleared land, about 700 feet east of the summit of the very high, steep ridge, east of Seeley creek, on north side of line fence. It is on line between the property of Reuben Berry and Mrs. C. Nichols. This monument has heaved 4 inches, and has its east corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 193 — HIGHWAY STONE 1.

Is a highway monument standing on east side of Elmira plank road, 150 feet south of State Line Hotel. It is on line between the property of Mary Weeks and A. J. Pedrick. This monument was found to be in good condition in every respect.

MONUMENT No. 194 — RAILROAD STONE 1.

Is a small monument standing on east side of the track of the Tioga branch of the New York, Lake Erie and Western railroad, about 200 feet north of State Line railroad station. This monument was found to be in good condition in every respect.

MONUMENT No. 195 — MILESTONE 79.

Is a highway monument standing on the west side of lightly traveled road, upon a steep bank 450 feet west of monument No. 194, 75 feet south of a gate in road and at east end of stone wall. It is on line between the property of Wilson and Roy. This monument was found to be in good condition in every respect.

MONUMENT No. 196 — HIGHWAY STONE 1.

Is a highway monument standing about 20 feet east of the north end of a highway leading south into Millerton in cultivated field and under line fence. It is on the property of Nathaniel Wilson. This monument has its south side chipped, and has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 197 — MILESTONE 80 AND COUNTY STONE.

Is a highway monument standing in a narrow swamp, upon the south side of a highway laid out along the boundary line, but not worked, and about 1,150 feet west of monument No. 196. It marks the corners of Bradford and Tioga counties, Pennsylvania. It is on line between the property of James McSolly and Alvin Miller. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 198 — HIGHWAY STONE 1.

Is a highway monument standing at west end of boundary line road at its junction with road running southerly to Millerton. It is on line between the property of Alvin Miller and Thaddeus Mitchell. This monument leans slightly to the north, otherwise it was found to be in good condition.

MONUMENT No. 199 — MILESTONE 81.

Is a small monument standing on the east side of a narrow summit of the high ridge, at the southeast corner of a piece of woods, alongside of worm fence and 990 feet west of monument No. 198. It is on line between the property of Alvin Miller and Alexander Lewis. This monument was found to be in good condition in every respect.

MONUMENT No. 200 — HIGHWAY STONE 1.

Is a highway monument standing on east side of highway on steep, southerly slope, about 150 feet west of the residence of Mrs. Russell. It is on line between the property of Samuel Josh and Charles Bly. This monument was found to be in good condition in every respect.

MONUMENT No. 201 — MILESTONE 82 AND COUNTY STONE 1.

Is a highway monument standing on the east side of a road running south, about 500 feet south of the summit. It marks the corner of the counties of Chemung and Steuben, New York. It is on line between the property of Samuel Miller and Frank Allen. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 202 — MILESTONE 83.

Is a small monument standing about 10 feet north of line fence in cleared land, upon the summit of a low ridge which crosses the boundary line diagonally. It is on line between the property of William Curran and Mrs. Buchanan. This monument was found to be in good condition in every respect.

MONUMENT No. 203 — MILESTONE 84.

Is a small monument standing in an open field, 10 paces south of fence in the rear (north) of a dwellinghouse and 825 feet from the point at which the boundary line turns to the southeast. It is on line between the property of Simon Nichols and Mrs. Anna Comfort. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 204 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, about 300 feet east of the residence of Albert Buchanan, and where the road turns to the southeast. It is on line between the property of Simon Nichols and Mrs. Anna Comfort. This monument has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 205 — HIGHWAY STONE 2.

Is a highway monument standing on south side of boundary line road at its junction with road running northerly, and about 150 feet southeast of a small frame schoolhouse. It is on line between the property of Eugene Tobey and S. L. Kelley. This monument has its edges slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 206 — MILESTONE 85.

Is a small monument standing on south side of boundary line road about 350 feet east of brook, which crosses road, and 15 feet north of wire fence on south side of road. It is on line between the property of Eugene Tobey and Christopher Tobey. This monument was found to be in good condition in every respect.

MONUMENT No. 207 — HIGHWAY STONE 1.

Is a highway monument standing on south side of boundary line road at its junction with road running southwesterly into Pennsylvania. It is on line between the property of Patrick Mahar and Christopher Tobey. This monument was found to be in good condition in every respect.

MONUMENT No. 208 — HIGHWAY STONE 2.

Is a highway monument standing at west end of boundary line road under stump fence. It is on line between the property of Patrick Mahar and Christopher Tobey. This monument has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 209 — MILESTONE 86.

Is a small monument standing on a westerly slope, 800 feet west of summit, at south edge of thick woods under a stump and stone fence. It is on line between the property of Charles Andrews and David Hulsander. This monument was found to be in good condition in every respect.

MONUMENT No. 210 — MILESTONE 87.

Is a small monument standing near the bottom of a bluff, at the east side of a narrow swamp, 237.4 feet east of monument No. 211. It is on line between the property of Niles and Rockwell. This monument has its southeast corner badly broken, otherwise it was found to be in good condition.

MONUMENT No. 211 — HIGHWAY STONE 1.

Is a highway monument standing on west side of a highway, about 300 feet south of Niles' residence. It is on line between the

property of Niles and Rockwell. This monument was found to be in good condition in every respect.

MONUMENT No. 212—MILESTONE 88 AND TOWN STONE 1.

Is a small monument with diagonal grooves, standing in the southeast corner of a piece of woods, northwest corner of a brush lot, at south end of stump fence, and about one-quarter of a mile south of Schumacker's residence. It is on line between the property of Garry Schumacker and Andrew Maxwell. This monument marks the corner of Caton and Lindley, Steuben county, New York. This monument was found to be in good condition in every respect.

MONUMENT No. 213 — HIGHWAY STONE 1.

Is a highway monument standing on west side of a road leading from Lawrenceville to Elmira. It is on line between the property of Harrison Siger and Albertus Paliff. This monument was found to be in good condition in every respect.

MONUMENT No. 214 — MILESTONE 89.

Is a small monument standing in cleared field, on southeasterly slope of a ridge, east of the Tioga river, 500 feet from summit, at the end of line fence and fence running northerly. It is on line between the property of John Tillon and Mrs. Ellison. This monument was found to be in good condition in every respect.

MONUMENT No. 215 — HIGHWAY STONE 1.

Is a highway monument standing on west side of a highway leading from Lawrenceville to Elmira, and just south of where the highway turns sharply to the west. It is on line between the property of Sam Coons and A. Ward. This monument has its north edge chipped, otherwise it was found to be in good condition.

MONUMENT No. 216 — RAILROAD STONE 1.

Is a highway monument standing at the northwest corner of the Erie railroad station, in the village of Lawrenceville. This monument has its edges and sides slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 217 — RIVER STONE 1.

Is a small monument standing upon the river flats, about 100 feet west of the left hand bank of the Tioga river, in a garden 75 feet northeast of the residence of W. S. Smith, and 3 feet south of line fence. It is on line between the property of W. S. Smith and B. H. Parkhurst. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 218 — MILESTONE 90.

Is a small monument standing about 100 feet north of State street in the village of Lawrenceville, at the northeast corner of Kuehl's barn, and about 1,260 feet east of monument No. 219. It is on line between the property of Kuehl and Harraway. This monument was found to be in good condition in every respect.

MONUMENT No. 219 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of Main street in the village of Lawrenceville, about 500 feet south of bridge crossing the Cowanesque river. It is on line between the property of Parkhurst and Hill. This monument was found to be in good condition in every respect.

MONUMENT No. 220 — RIVER STONE 1.

Is a small monument standing on the river flats about 100 feet east of the Cowanesque river, 75 feet north of the residence of Niles Freeling, and 15 feet east of a large elm tree. It is on line between the property of Niles Freeling and B. H. Parkhurst. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 221 — HIGHWAY STONE 2.

Is a highway monument standing on northwest side of Cowanesque river road, northwest of grist mill. It is on line between the property of Eaton and Ellison. This monument has its northeast corner badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 222 — MILESTONE 91.

Is a small monument standing on a steep southerly slope, in open woods, about 250 feet west of the crest of the ridge, about 250 feet south of a clearing on the summit, and 5 paces southwest of 18-inch pine. It is on line between the property of Eaton and Ellison. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 223 — HIGHWAY STONE 1.

Is a small monument standing in thick woods, on the northeast side of an abandoned wood road. It is on line between the property of Wood and Watson. This monument was found to be in good condition in every respect.

MONUMENT No. 224 — HIGHWAY STONE 2.

Is a small monument standing on east side of lately abandoned wood road. It is on line between the property of Wood and Watson. This monument was found to be in good condition in every respect.

MONUMENT No. 225 — MILESTONE 92.

Is a small monument standing in thick woods on a gentle westerly slope, 125 feet west of a clearing and 19 paces west of west end of line fence. It is on line between the property of Ford and Stewart. This monument was found to be in good condition in every respect.

MONUMENT No. 226 — HIGHWAY STONE 1.

Is a highway monument standing at the east end of boundary line road on south side of road, at north edge of woods and 150 feet east of Baker's residence. It is on line between the property of Lagrana Brant and S. A. Baker. This monument has heaved 8 inches, otherwise it was found to be in good condition.

MONUMENT No. 227 — MILESTONE 93.

Is a highway monument standing in the east edge of bush woods, on south side of boundary line road, near the top of a westerly slope, and about 150 feet southwest of Sliter's residence. It

on line between the property of Ruth Sliter and Charles Baker. This monument was found to be in good condition in every respect.

MONUMENT No. 228 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, at its junction with road running southerly. It is on line between the property of Daniel Stoddard and George Star. This monument has its northeast and northwest corners slightly chipped, and has heaved four inches, otherwise it was found to be in good condition.

MONUMENT No. 229 — MILESTONE 94 AND TOWN STONE.

Is a highway monument standing on north side of boundary line road about 275 feet east of the summit of the ridge. It marks the corner of the towns of Lindley and Tuscarora, Steuben county, New York. It is on line between the property of Samuel Morehouse and Edwin Baker. This monument leans slightly to the south, otherwise it was found to be in good condition.

MONUMENT No. 230 — HIGHWAY STONE 1.

Is a highway monument standing on north side of boundary line road on steep westerly slope, and at junction with road running northerly. It is on line between the property of Alvin O'Dell and Edwin Thomas. This monument was found to be in good condition in every respect.

MONUMENT No. 231 — MILESTONE 95 AND TOWN STONE.

Is a highway monument standing on north side of boundary line road 30 feet east of the southeast corner of a grove of pines which stands about on the summit. It marks the corner of the towns of Nelson and Lawrence, Tioga county, Pennsylvania. It is on line between the property of William Price and Augustus Senago. This monument was found to be in good condition in every respect.

MONUMENT No. 232 — HIGHWAY STONE 1.

Is a highway monument standing on north side of boundary line road at its west end and at the junction of road leading south-

west into the village of Nelson, 203 feet west of monument No. 231. It is on line between the property of William Pierce and Agustus Senago. This monument has its southeast and southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 233 — MILESTONE 96.

Is a small monument standing on gentle westerly slope, south side of a piece of woods, under a stump fence, 1,354 feet east of monument No. 234, and at Pennsylvania farm corner. It is on line between the property of Baxter and Hoyt. This monument was found to be in good condition in every respect.

MONUMENT No. 234 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway, running northerly from the village of Nelson on top of the summit. It is on the property of Harry Baxter. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 235 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of a highway which follows the east bank of Baldwin's creek. It is on the property of Harry Baxter. This monument was found to be in good condition in every respect.

MONUMENT No. 236 — MILESTONE 97.

Is a small monument standing in a clay swamp, at bottom of deep valley, about 525 feet west of monument No. 235, and 230 feet west of brook and about 25 feet north of fence. It is on line between the property of Harry Baxter and H. S. Bristol. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 237 — RAILROAD STONE 1.

Is a small monument standing on the west side of the track of the Addison and Northern Pennsylvania railroad. This monument was found to be in good condition in every respect.

MONUMENT No. 238 — MILESTONE 98.

Is a small monument standing in a small cleared field, gentle southeasterly slope, five feet north of line fence, and about 160 feet east of woods, and 69 feet west of the southeast corner of lot 139, in Tuscarora. It is on line between the property of C. M. Preston and T. Cummings. This monument was found to be in good condition in every respect.

MONUMENT No. 239 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, leading northerly from Elkland to Addison and 300 feet south of summit. It is on line between the property of John Cummings and Daniel Tubbs. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 240 — MILESTONE 99.

Is a small monument standing on steep westerly slope, 30 feet west of west edge of woods, and 1,531 feet east of monument No. 241, and under line fence. It is on line between the property of O. H. Patterson and D. H. Bates. This monument was found to be in good condition in every respect.

MONUMENT No. 241 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the main road leading northerly from Elkland to Addison, and about 500 feet north of bridge crossing brook. It is on line between the property of O. H. Patterson and D. H. Bates. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 242 — MILESTONE 100, AND TOWN STONE.

Is a small monument which stood originally in the bed of a brook, but having been carried away on several occasions, by the freshets, it was set, October 4, 1893, 100 feet east of its original position, on the west side of a highway, leading northwest from the village of Elkland. An iron bar 6 feet long and 1½ inches in diameter, was placed in the original position of milestone 100, driven in the ground about 5 feet. This bar marks the corner of the towns of

Tuscarora and Woodhull, Steuben county, New York. The highway monument which stood just to the west was removed, because it stood on road which is now abandoned. This monument was left standing in perfect condition.

MONUMENT No. 243 — MILESTONE 101.

Is a small monument standing in cleared land, on south side of an apple orchard, on gentle southerly slope, 221.4 feet east of monument No. 244. It is on line between the property of Hoyt Tubbs and Mrs. L. D. Mack. This monument has its northwest corner broken and has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 244 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, leading southerly to Osceola, and about 100 feet southwest from Mack's house. It is on line between the property of Hoyt Tubbs and Mrs. L. D. Mack. This monument was found to be in good condition in every respect.

MONUMENT No. 245 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a highway, 25 feet east of creek and 50 feet southwest of James Whitmore's house. It is on property of James Whitmore. This monument has its edges slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 246 — MILESTONE 102, AND TOWN STONE.

Is a small monument with diagonal grooves standing in a brush lot, on level ground in land that was once cleared, about 10 feet north of line fence and 17 paces east of fence running northerly. It marks the corner of Osceola and Durfield, in Tioga county, Pennsylvania. It is on the line between the property of Ed. Tubbs and Peter Spears. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 247 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, on slight westerly slope, about 400 feet east of the residence of J. Baker. It is on line between the property of E. Baker and Ed. Tubbs. This monument was found to be in good condition in every respect.

MONUMENT No. 248 — MILESTONE 103.

Is a small monument standing in cleared field at the foot of a steep westerly slope, 240 feet east of brook and under line fence. It is on line between the property of the Bullin and Coates estate. This monument has heaved 11 inches, but stands firmly, otherwise it was found to be in good condition.

MONUMENT No. 249 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, which leads northerly along the west bank of Catlin creek and about 300 feet west of creek. It is on line between the property of Robert Baker and G. Catlin. This monument was heaved 7 inches and leans to the south, otherwise it was found to be in good condition.

MONUMENT No. 250 — MILESTONE 104.

Is a small monument standing on an easterly slope, under line fence and at junction of fence running north, 568.6 feet west of monument No. 249. It is on line between the property of Baker and Humphreys. This monument has heaved 12 inches, otherwise it was found to be in good condition.

MONUMENT No. 251 — MILESTONE 105.

Is a small monument standing on level ground, on the northeast side of a summit of a high steep ridge in young woods, northwesterly from 8 pine trees and just at brow of northeasterly slope. It is on line between the property of J. W. Hammond and G. W. Bowman. This monument was found to be in good condition in every respect.

MONUMENT No. 252 — MILESTONE 106.

Is a small monument standing on a steep northeasterly slope, on west edge of wood road, in a wilderness of bushes and dead trees about 135 feet north of wood road, and north 51 degrees west, 21.5 feet west of a living hemlock, 20 inches in diameter, and about 475 feet west of lower road, in a narrow cleared strip about 30 feet wide. It is on line between the property of Moonhouse and Hammond. This monument was found to be in good condition in every respect.

MONUMENT No. 253 — SUMMIT STONE.

Is a small monument standing 1,103.3 feet west of monument No. 252, on level ground on top of summit of very high ridge, about 50 feet south of the brow of the summit, overlooking the boundary 20 miles to the east. It is on line between property of Billings and Gardner. This monument was found to be in good condition in every respect.

MONUMENT No. 254 — MILESTONE 107.

Is a small monument standing in the south edge of cleared land and north edge of grove of young saplings, under line wire fence, and about 350 feet west of worm fence running northerly. It is on line between the property of Hurst and Billings. This monument has heaved 7 inches, otherwise it was found to be in good condition.

MONUMENT No. 255 — HIGHWAY STONE 1.

Is a highway monument standing at the east end of boundary line road and south end of road running northerly. It is 16.5 feet east of the corner of the towns of Woodhull and Troupsburg, in Steuben county, New York. It is on line between the property of C. N. Woods and Daniel Billings. This monument was found to be in good condition in every respect.

MONUMENT No. 256 — HIGHWAY STONE 2.

Is a highway monument standing on northwest side of a road running southwesterly about 25 feet southwest of the west end

of boundary line road and under line fence. It is on line between the property of Irving Jordan and Henry McFall. This monument was found to be in good condition in every respect.

MONUMENT No. 257 — MILESTONE 108.

Is a small monument standing 1,061 feet west of monument No. 256 in cleared land, on a steep southerly slope, and about 800 feet north of road running southwesterly. It is on line between the property of M. B. Jordan and William Lattimore. This monument has heaved 3 inches and has its northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 258 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from Austinburg to Addison. It is on the property of R. P. Schooner. This monument has its north edge chipped, otherwise it was found to be in good condition.

MONUMENT No. 259 — MILESTONE 109.

Is a small monument standing in cleared land at the west edge of the summit of a gravel bluff, north of Troup's creek, 978 feet west of monument No. 258 and under worm fence. It is on line between the property of H. Murdock and Ed. Murdock. This monument was found to be in good condition in every respect.

MONUMENT No. 260 — HIGHWAY STONE 1.

Is a highway monument standing on westerly side of a highway leading from South Troupsburg to Austinburg, and about 150 feet north of bridge crossing Hilltown creek. It is on line between the property of H. B. Murdock and Ed. Murdock. This monument was found to be in good condition in every respect.

MONUMENT No. 261 — MILESTONE 110.

Is a small monument standing 2,141 feet west of monument No. 260, on a southerly slope between two small knolls, in cleared field, north side of line worm fence and about 350 feet northwest of bridge crossing Hilltown creek. It is on line between the prop-

erty of Edward Murdock and Rhen Cowen. This monument was found to be in good condition in every respect.

MONUMENT No. 262 — MILESTONE 111.

Is a small monument standing near the foot of a northwesterly slope of a high ridge bounding a semi-circular cove on the south, in cleared land, on south side of woods and north side of line fence, and 251 feet east of the corners of lots 100 and 101 in the town of Troupsburg, Steuben county, New York. It is on line between the property of H. Card and W. C. Seeley. This monument has heaved 4 inches and has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 263 — MILESTONE 112.

Is a small monument standing on south edge of open woods on nearly level ground, 150 feet east of ravine on south side of line worm fence and at junction of fence running southerly and about 1,000 feet north of highway, paralleling the boundary into Pennsylvania. It on line between the property of Cynthia Dougherty and T. Hubbard. This monument was found to be in good condition in every respect.

MONUMENT No. 264 — MILESTONE 113.

Is a small monument standing in the north edge of thick woods, on a little knoll south of a swampy brook on level ground under line fence about 200 feet east of large heavy woods in New York, and 174 feet west of the southwest corner of lot 97 in the town of Troupsburg, Steuben county, N. Y. It is on line between the property of Hirman Morton and A. J. McIntyre. This monument was found to be in good condition in every respect.

MONUMENT No. 265 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading northerly from Brookfield. It is on line between the property of Mrs. E. G. Grady and Mrs. Melvine. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 266 — MILESTONE 114.

Is a small monument standing near the top of a southeasterly slope, north of line fence, 1,528.5 feet east of monument No. 267, and about 56 feet west of the corner of lots 94 and 95 in the town of Troupsburg, Steuben county, New York. It is on line between the property of Robert McCullough and Robert Ramsey. This monument was found to be in good condition in every respect.

MONUMENT No. 267 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of the west highway leading north from Brookfield postoffice. It is on line between the property of Ralph McCullough and Melvin Baker. This monument was found to be in good condition in every respect.

MONUMENT No. 268 — MILESTONE 115 AND COUNTY STONE.

Is a small monument with diagonal grooves, standing on a steep northwesterly slope, about 100 feet west of the summit of the ridge under and at the east end of worm line fence. It marks the corner of Potter and Tioga counties, Pennsylvania. It is on line between the property of C. P. Gill and Ralph McCullough. This monument was found to be in good condition in every respect.

MONUMENT No. 269 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading northerly from North Fork postoffice. It is on line between the property of Daniel Chase and George Lewis. This monument has its four corners broken, otherwise it was found to be in good condition.

MONUMENT No. 270 — MILESTONE 116.

Is a small monument standing on steep westerly slope about 500 feet east of monument No. 271 and under line barb-wire fence. It is on line between the property of George A. Carr and William P. Chase. This monument has heaved 6 inches, and has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 271 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway, leading up to the north fork of the Cowanesque river. It is on the property of George A. Carr. This monument was found to be in good condition in every respect.

MONUMENT No. 272 — TOWN STONE.

Is a small monument with diagonal grooves, marking the corner of the towns of West Union and Troupsburg, Steuben county, N. Y. It stands on an easterly slope in cleared field, on south side of line fence and about 800 feet west of monument No. 271. It is on line between the property of Reuben Stiles, George A. Carr and Nathan Allen. This monument was found to be in good condition in every respect.

MONUMENT No. 273 — MILESTONE 117.

Is a small monument standing on southwesterly slope, in open woods about 300 feet east of wood road, and about 1,301 feet east of monument No. 274. It is on line between the property of A. Saxton and Walter Sathen. This monument was found to be in good condition in every respect.

MONUMENT No. 274 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from North Fork to Rexfield. It is on line between the property of A. Saxton and Walter Sathen. This monument has heaved 4 inches and has its southwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 275 — MILESTONE 118.

Is a small monument standing in thick woods, on a very steep northerly slope, about two-thirds down the ridge, and about where the ridge slopes east and west, about 400 feet east of a clearing 500 feet south of creek, and 7 paces east of a very tall hemlock. It is on the property of J. N. Gill. This monument was found to be in good condition in every respect.

MONUMENT No. 276 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of an abandoned boundary line road, and about 2,000 feet west of monument No. 275, and 100 feet south of small frame house. It is on line between the property of Stetson and R. Smith. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 277 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a highway leading from Whitesville to Harrison Valley, about 120 feet southwest of Smith's house and at west end of short piece of boundary line road. It is on line between the property of John Riley and R. Smith. This monument was found to be in good condition in every respect.

MONUMENT No. 278 — MILESTONE 119.

Is a small monument standing at the south side of a garden among a few scattering maples, and about 70 feet southwest of a dwelling, and 174.75 feet west of monument No. 277 in a stone line fence. It is on line between the property of Yocum and John Riley. This monument was found to be in good condition in every respect.

MONUMENT No. 279 — SECTION STONE.

Is a small monument with diagonal grooves, standing 1,283.7 feet west of monument No. 278, on level ground, west edge of woods, under line fence. It marks the southeast corner of the Elice tract. It is on line between the property of Laranoh Yocum and John Riley. This monument was found to be in good condition in every respect.

MONUMENT No. 280 — MILESTONE 120.

Is a small monument standing about 147 feet west of the southwest corner of lot 8 of the Elice tract, upon a short, easterly slope near the foot, about 250 feet west of a small rivulet, which crosses the line into New York, on the north side of an open grove of beech and maple, and 3 feet north of line barb wire fence. It is

on the property of William Warren. This monument has its northeast corner broken, otherwise it was found to be in good condition.

MONUMENT No. 281 — MILESTONE 121 AND TOWN STONE.

Is a small monument with diagonal grooves standing on level, cleared land, on the summit west of Rose Brook valley, about 1,500 feet west of the brook, on south side of line fence. It marks the corner of the towns of Harrison and Bingham, in Potter county, Pennsylvania. It is on line between the property of B. W. Lawrence and O. D. Hubbard. This monument has heaved 4 inches and has one of its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 282 — HIGHWAY STONE 1.

Is a highway monument standing 2,538.4 feet west of monument No. 281, on the west side of highway leading from White's Corners to Wellsville. It is on line between the property of P. W. Lawrence and R. B. Cutler. This monument was found to be in good condition in every respect.

MONUMENT No. 283 — MILESTONE 122.

Is a small monument standing in cleared land, on very slight westerly slope, north side of line fence. It is on the property of P. W. Lawrence. This monument was found to be in good condition in every respect.

MONUMENT No. 284 — COUNTY STONE.

Is a small monument with diagonal grooves, standing upon level ground, a short distance west of a low bluff sloping east, and 699.6 feet west of monument No. 283. It marks the corner of the Steuben and Allegany counties, New York. It is on line between the property of Wellman Stafford and John Hubbard. This monument could not be found.

MONUMENT No. 285 — HIGHWAY STONE 1.

Is a highway monument on the west side of a highway leading from Spring Mills into Pennsylvania. It is on the property o

William Cobb. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 286 — MILESTONE 123.

Is a small monument standing on a gentle, westerly slope in cleared land, 473 feet west of monument No. 285. It is on the property of William Cobb. This monument was found to be in good condition in every respect.

MONUMENT No. 287 — MILESTONE 124.

Is a small monument standing in a gap in a stone wall upon a gentle, westerly slope, about 200 feet west of the summit, west from the village of Spring Mills, and 44 paces west of board fence running southerly in cleared field. It is on the property of L. B. Howe. This monument has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 288 — MILESTONE 125.

Is a small monument standing in a clump of small beeches and cherries, on southwesterly slope, on south edge of woods, about 1,000 feet northeast of Briggs' residence, and 1,500 feet east of Ainsworth creek, on north side of line board fence. It is on the property of the Briggs estate. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 289 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of Ainsworth creek road, leading from Spring Mills south into Pennsylvania. It is on the property of Anson Richmond. This monument has heaved 7 inches, otherwise it was found to be in good condition.

MONUMENT No. 290 — HIGHWAY STONE 2.

Is a highway monument standing on south side of boundary line road, about 500 feet east of milestone No. 126, and where it turns to the northeast. It is on the property of Anson Richmond. This monument was found to be in good condition in every respect.

MONUMENT No. 291 — MILESTONE 126.

Is a highway monument standing on the south side of road running on the line in New York State, about 15 feet north of the northwest corner of Anson Richmond's barn. It is on the property of Anson Richmond. This monument was found to be in good condition in every respect.

MONUMENT No. 292 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, and where the road turns to the south. It is on the property of George Hand. This monument was found to be in good condition.

MONUMENT No. 293—MILESTONE 127 AND TOWN STONE 1.

Is a small monument with diagonal grooves standing upon a steep northwesterly slope, 5 feet west from a line drawn from Warren Kenyon's barn through Harvey Richmond's white house. On the New York side the woods have lately been cut off and on the Pennsylvania side 15 or 20 years growth. It is in thick briars about 100 feet east of heavy woods in Pennsylvania, 30 feet east of a 10-inch hemlock, and 60 feet north of a hemlock stump 40 feet high. It marks the corners of the towns of Bingham and Genesee, Potter county, Pennsylvania. It is on the property of Ida Payne in New York and no owners in Pennsylvania. This monument was found to be in good condition in every respect.

MONUMENT No. 294 — HIGHWAY STONE 1.

Is a highway monument standing on east side of Cryden creek road, about 25 feet southwest of the southwest corner of the residence of Mark Ellsworth. It is on line between the property of Mark Ellsworth and Eugene Hurd. This monument has its north and south sides badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 295 — MILESTONE 128.

Is a small monument standing on slight southerly slope, in cleared field, 75 feet south of clump of pines, 525.7 feet west

of monument No. 294, and about 300 feet west of a small brook. It is on the property of E. B. Teller. This monument has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 296 — RAILROAD STONE 1.

Is a highway monument standing on the northeast side of the Buffalo and Susquehanna railroad, 1,150 feet west of monument No. 295, about 50 feet east from the right hand bank of the Genesee river and about 150 feet north of railroad bridge. This monument was found to be in good condition in every respect.

MONUMENT No. 297 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Genesee Forks northerly along the west bank of the Genesee river. It is on line between the property of the Cobb estate and G. W. Pierce. This monument was found to be in good condition in every respect.

MONUMENT No. 298 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of a highway, leading from Genesee Forks to Shongo. It is on line between the property of the Cobb estate and G. W. Paine. This monument was found to be in good condition in every respect.

MONUMENT No. 299 — MILESTONE 129.

Is a small monument standing on a steep northeasterly slope, covered with briars, fallen logs, tree tops and burnt timber, and 1,180.3 feet west of monument No. 298. It is on the property of D. W. Kane. This monument was found to be in good condition in every respect.

MONUMENT No. 300 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, leading from O'Donnell's Mills to the Irish settlement. It is on line between the property of F. R. McHale and Patrick O'Hagen. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 301 — MILESTONE 130.

Is a small monument standing 690 feet east of monument No. 302, upon a short northerly slope, in cleared land about 90 paces east of private road leading to residence of Bryan McGinnis, and 7½ feet west of the southwest corner of Bryan McGinnis' property. It is on line between the property of Bryan McGinnis and J. D. McHale. This monument was found to be in good condition in every respect.

MONUMENT No. 302 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading to the Irish settlement, 690 feet west of monument No. 301. It is on line between the property of Bryan McGinnis and J. D. McHale. This monument has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 303 — MILESTONE 131.

Is a small monument standing in cultivated land, upon a slight southerly slope about 2,000 feet north of highway, northerly of some maples, 3 feet north of worm line fence and about 250 feet east of board fence running southerly. It is on line between the property of McCabe and O'Donnell. This monument has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 304 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of an abandoned wood road, leading to the Irish settlement. It is on line between the property of James O'Hara and Patrick Hart. This monument has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 305 — HIGHWAY STONE 2.

Is a highway monument standing on southeast side of Ore Bed creek road, quite close to wagon track. It is on line between the property of James O'Hara and Patrick Hart. This monument has its southwest and northwest corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 306 — MILESTONE 132.

Is a small monument standing about 770 feet west of Ore Bed creek, in a small depression in scrubby woods, about 40 feet south of road leading to Maxwell's residence, 60 feet southeast of broken elm, 35 feet in height, about 100 feet east of clearing in Pennsylvania and about 20 feet south of 18-inch tall basswood. It is on line between the property of Thomas Maxwell and Patrick Hart. This monument was found to be in good condition in every respect.

MONUMENT No. 307 — HIGHWAY STONE AND TOWN STONE 1.

Is a highway monument standing on the west side of a highway leading from the Irish settlement, on the second summit west of monument No. 306, and on south side of line fence. This monument marks the corner of the towns of Alma and Willing, Allegany county, New York. This monument was found to be in good condition in every respect.

MONUMENT No. 308 — TOWN STONE 2.

Is a small monument with diagonal grooves, standing on a westerly slope, about 1,200 feet west of monument No. 307, about 430 feet east of milestone 133, 3 feet north of line fence and at junction of fence running southerly. This monument marks the corner of the towns of Genesee and Oswayo, Potter county, Pennsylvania. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 309 — MILESTONE 133.

Is a small monument standing in cultivated land on a steep westerly slope, 426.6 feet east of monument No. 310, and close to north side of fence. This monument has its top almost flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 310 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a road in bottom of valley. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 311 — HIGHWAY STONE 2.

Is a highway monument standing on west side of highway leading from Wellsville to Coudersport. It is on line between the property of Thomas Hart and Peter Nolan. This monument has its northeast and northwest corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 312 — MILESTONE 134.

Is a small monument standing upon level top of a knoll, between two shallow ravines of Red Water creek on level cultivated ground, about 30 feet east of a small rivulet and 350 feet west of monument No. 311, and 2 feet south of worm fence. It is on line between the property of Patrick Marley and Peter Nolan. This monument was found to be in good condition in every respect.

MONUMENT No. 313 — MILESTONE 135.

Is a small monument standing in thick open woods, on a gentle northwesterly slope, at the fork of two wood roads, one bearing northwesterly, the other southwesterly. The timber surrounding the milestone is of hard wood. This monument is on line between the property of John Tomany and Mary O'Brien. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 314 — MILESTONE 136.

Is a small monument standing on a steep westerly slope, slightly northerly, in thick woods, 950 feet east of a brook, in a deep ravine, south 50 degrees west 40 feet from an 18-inch live hemlock and north 15 degrees east 25 feet from a 6-inch beech, and on southwest side of a narrow path leading up the hill. It is on line between the property of Empire Gas Company and James and John O'Donnell. This monument was found to be in good condition in every respect.

MONUMENT No. 315 — HIGHWAY STONE 1.

Is a highway monument standing on west side of a highway leading from Alma to Irish settlement, about 75 feet northerly from southeast corner of the residence of M. H. Dutton. It is on the property of M. H. Dutton. This monument has all its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 316 — MILESTONE 136 5-8.

Is a small monument standing at the west edge of the original sixth latitude stone, in thick woods on a steep northeasterly slope, about 480 feet west of the south branch of Crandall creek. It is on line between the property of Weston Brothers and C. M. Weybull. This monument was erroneously marked by the stonecutter 136 1-8 mile, otherwise it was found to be in good condition.

MONUMENT No. 317 — MILESTONE 137.

Is a small monument standing in thick open woods, on a northeasterly slope, 600 feet east of the summit of the ridge, and about 2,000 feet west of monument No. 316. It is on line between the property of Weston Brothers and Wallace Jones. This monument was found to be in good condition in every respect.

MONUMENT No. 318 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading southerly from along postoffice, about 300 feet north of oil derrick, and 15 feet west of wagon track. It is on line between the property of James Shields and John Shields. This monument was found to be in good condition in every respect.

MONUMENT No. 319 — MILESTONE 138.

Is a small monument standing on a steep westerly slope, thickly covered with windfalls and briars, about 250 feet west of the summit of the ridge, 75 feet east of an abandoned road, and 1,173 feet west of monument No. 318, in the vicinity of three or four dead hemlocks, and just to the north of four or five live hemlocks. It is on line between the property of James Shields and John Shields. This monument was found to be in good condition in every respect.

MONUMENT No. 320 — TOWN STONE.

Is a small monument marked on top " Λ ", standing at the south side of monument, which was set in 1798 to mark the southeast corner of the Holland Land Company Purchase. The north edge of the new monument indicates the line. It stands upon a steep northeasterly slope, about two-thirds up the hill, 600 feet west of

a deep ravine, and it marks the corner of the towns of Bolivar and Alma, Allegany county, New York. It is on line between the property of J. J. Elliott and the Mushrow estate. This monument was found to be in good condition in every respect.

MONUMENT No. 321 — MILESTONE 139.

Is a small monument standing on steep southerly slope, about 500 feet south of where the slope begins to descend very rapidly, about 150 feet north of the summit, 1,148.6 feet west of monument No. 320, and south 3 degrees west from the residence of E. M. Whipple, which stands on the highway leading from Alma post-office to South Bolivar. It is on line between the property of William Hyatt and E. M. Whipple. This monument was found to be in good condition in every respect.

MONUMENT No. 322 — TOWN STONE 1.

Is a small monument with diagonal grooves, and marks the corner of the towns of Oswayo and Sharon. It is on a steep northerly slope about 1,800 feet east of monument No. 323, south edge of cleared land, about 30 feet north of road following the line, 75 feet west of large shaggy beech, 614 feet east of the southwest corner of section 1, township 1, range 1, of the Holland Land Company's Purchase. It is on the property of William Mushrow and James Dotly, in Pennsylvania, and J. C. Gladsly, in New York. This monument was found to be in good condition in every respect.

MONUMENT No. 323 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a private road where it turns to follow boundary to the east. It is on line between the property of William M. Hyatt and P. W. and Ezekiel Griffith. This monument was found to be in good condition in every respect.

MONUMENT No. 324 — MILESTONE 140.

Is a small monument standing at foot of steep northerly slope, about 10 feet above level of the swamp, in thick woods, beech and hemlock, and 782.5 feet west of monument No. 323. It is on line

between the property of Gilbert Chaple and W. T. Lewis. This monument was found to be in good condition in every respect.

MONUMENT No. 325 — RIVER STONE.

Is a small monument standing on the southeast edge of the Honeyoe flats, at northwest side of a flood water channel of the creek, about 50 feet south of fence on property of Ezekiel Griffith. This monument was found to have its top entirely broken off.

MONUMENT No. 326 — MILESTONE 141.

Is a small monument standing in cleared land, 2 feet north of line fence, and 1,148.3 feet east of monument 327, and about 200 feet west of lane. It is on line between the property of George Yeakel and Croger's estate. This monument was found to be in good condition in every respect.

MONUMENT No. 327 — HIGHWAY STONE 1.

Is a highway monument standing on southeast side of State Line road, leading from South Bolivar to Shingle House. It is on line between the property of Nathan Wayward and A. F. Smith. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 328 — MILESTONE 142.

Is a highway monument standing on west side of road leading from Goldsmith's corner. It is on line between the property of H. Berdic and Mrs. Blakely. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 329 — HIGHWAY STONE 1.

Is a highway monument standing on east side of road, which is little used, under board fence, which is about 15 feet north of brook, and about 400 feet north of Stillman's house. It is on line between the property of O. B. Stillman and the Willets estate. This monument was found to be in good condition in every respect.

MONUMENT No. 330 — MILESTONE 143.

Is a small monument standing in thick underbrush, on very steep southerly slope, 150 feet south of top of slope, about 300 feet east of summit, 10 feet south of nearest of 3 fallen logs and 25 feet northeast of fallen stump. East Sharon schoolhouse bears about south 1 degree east from the stone. It is on property of Agustus Wheeler. This monument was found to be in good condition in every respect.

MONUMENT No. 331 — HIGHWAY STONE 1.

Is a highway monument standing on east side of road leading from East Sharon to Bolivar. It is on the property of Charles Burbank. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 332 — MILESTONE 144.

Is a highway monument standing on north side of short piece of road following the boundary line, about 370 feet west of where a run crosses the line and 1 foot south of fence. It is on line between the property of Mrs. Wolcott and L. P. Perry. This monument was found to be in good condition in every respect.

MONUMENT No. 333 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of the main road leading from Bolivar to Shingle House, about 75 feet south of Horse Run M. E. Church. It is on line between the property of Mrs. Wolcott and L. P. Perry. This monument has all four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 334 — MILESTONE 145.

Is a small monument standing on westerly slope, 271 feet east of monument No. 335, on north edge of woods and 2 feet north of stump line fence. It is on line between the property of A. Sullivan and M. Vanlowe and George Sherwood. This monument was found to be in good condition in every respect.

MONUMENT No. 335 — HIGHWAY STONE 1.

Is a highway monument standing on east side of road leading from Genesee to Shingle House, about 100 feet southeast of Frank Pratt's house. It is on line between the property of Frank Pratt and M. Vanlowe. This monument was found to be in good condition in every respect.

MONUMENT No. 336 — COUNTY STONE.

Is a small monument with diagonal grooves 3,592.6 feet west of monument No. 334 and 913.5 feet west of the northeast corner of Pennsylvania warrant No. 4,330, and marks the corner of Potter and McKean counties, Pennsylvania, on steep westerly slope in thick woods, 25 feet north of brow of hill, 15 feet north of large stump and 40 feet east of several 1-foot hemlocks. It is on line between the York estate and W. H. Lunn. This monument was found to be in good condition in every respect.

MONUMENT No. 337 — MILESTONE 146.

Is a small monument in thick woods, on steep westerly slope, 575 feet east of a brook in a deep ravine, on south side of a large fallen hemlock, 10 feet north of another hemlock and 20 feet northwest of large hemlock stump. It is on line between the property of George Case and the York estate. This monument was found to be in good condition in every respect.

MONUMENT No. 338 — MILESTONE 147.

Is a small monument standing about 100 feet west of a small brook running southerly, and 10 feet south of huge pine stump, and about 100 feet south of wood road, which nearly parallels the line. It is on line between the property of L. J. Carrier and C. G. Chandler. This monument was found to be in good condition in every respect.

MONUMENT No. 339 — HIGHWAY STONE 1.

Is a highway monument standing on west side of road, leading from Myrtle to Little Genesee. It is on line between the property of George Case and C. G. Chandler. This monument has its southeast and southwest corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 340 — MILESTONE 148.

Is a small monument standing in cultivated land, 60 feet south of old B. E. and C. R. R., 150 feet southeast of large clump of woods and 60 feet south of fence running east and west. It is on the property of B. E. and C. R. R. Co. This monument has all corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 341 — RAILROAD STONE 1.

Is a small monument standing about 30 feet south of B. E. and C. R. R., at east edge of lumber pile, and 800 feet east of monument No. 342. It is on the property of B. E. and C. R. R. Co. This monument has its four corners chipped, and has heaved 12 inches, otherwise it was found to be in good condition.

MONUMENT No. 342 — HIGHWAY STONE 1.

Is a highway monument standing on west side of road leading south from Main street, Ceres, about 100 feet southeast of Central New York and Western railroad station, in the village of Ceres. It is on the property of B. E. and C. R. R. Co. This monument was found to be in good condition in every respect.

MONUMENT No. 343 — HIGHWAY STONE 2.

Is a highway monument standing on south side of Main street, Ceres, at a point where Main street bends into New York, and at northeast corner of a cemetery in Pennsylvania. It is on the property of Charles Bell. This monument was found to be in good condition in every respect.

MONUMENT No. 344 — MILESTONE 149.

Is a highway monument standing on the south side of Main street, Ceres, south of Empire school building in Genesee, New York, 100 feet west of cemetery and under stump fence. It is on the property of Charles Bell. This monument was found to be in good condition in every respect.

MONUMENT No. 345 — HIGHWAY STONE 1.

Is a highway monument standing on the south side of Main street, Ceres, where it turns north and westerly into New York,

and about 50 feet north of Maxson's house. It is on the property of A. Maxson. This monument was found to be in good condition in every respect.

MONUMENT No. 346 — RAILROAD STONE 1.

Is a small monument standing on south side of Central New York and Western railroad track, midway between the tracks of the two railroads. It is on the property of B. E. and C. R. R. Co. This monument was found to be in good condition in every respect.

MONUMENT No. 347 — MILESTONE 150.

Is a small monument standing in a low swamp ground about 500 feet due south of V. P. Carter's barn, north edge of large timber, small growth of saplings to the north, 275 feet east of the corner of sections 49 and 57, in township 1, range 2, of the Holland Land Company's Purchase. It is on line between the property of V. P. Carter and William King. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 348 — RIVER STONE 1.

Is a small monument standing on cultivated land 30 feet from the left hand bank of river, 5 feet south of barb wire fence. It is line between the property of Myron Walters and Mrs. Coons. This monument was found to be in good condition in every respect.

MONUMENT No. 349 — COUNTY STONE 1.

Is a small monument with diagonal grooves, 1,043 feet east of monument No. 350, and marks the corner of Allegany and Cattaraugus counties, New York, in cleared land 15 feet south of line fence. It is on line between the property of V. P. Maxson and Miner Walton. This monument has heaved 3 inches and has its east corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 350 — MILESTONE 151.

Is a small monument standing 9 paces south of the south bank of the Oswayo, where it leaves Pennsylvania, and about 1,000 feet west of monument No. 349. It is on line between the property of J. M. Brown and the Coons estate. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 351 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway, leading from Portville to Ceres. It is on line between the property of Barber and Remington. This monument has its southeast, southwest and northwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 352 — MILESTONE 152.

Is a small monument standing in open scattered woods, upon a steep northerly slope, at the easterly edge of a cove, and about 850 feet east of the summit of a high ridge between the valleys of the Oswayo and the Allegany. It is on line between the property of Mrs. H. Kahoe and E. Shiver. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 353 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway, leading from Portville to Bullis Mills, opposite Love's residence. It is on line between the property of Emory Shiver and Myland Smith. This monument was found to be in good condition in every respect.

MONUMENT No. 354 — RAILROAD STONE 1.

Is a small monument situated in cleared land, about 150 feet west of monument No. 353, and about 4 feet east of where the track of the B. E. and C. R. R., originally stood. This monument has heaved 6 inches and has all its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 355 — RAILROAD STONE 2.

Is a small monument standing about 400 feet west of monument 354, in a field of the Western New York and Pennsylvania railroad. This monument has its southeast and southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 356 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of a highway, leading from Bullis Mills to Mill Grove. It is on line between the property of Stetson and Smith. This monument has its east corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 357 — MILESTONE 153.

Is a small monument standing in a narrow dyke, between the Allegany river and slough flood water channel, 36 feet west of a dead hemlock standing on the edge of the left bank of the river. It is on line between the property of Stetson and Smith. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 358 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway, leading from Portville to Eldred. It is on line between the property of E. P. Vaugh and the Lennon estate. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 359 — MILESTONE 154.

Is a small monument standing in thick weeds, on small knoll, about 15 feet west of the east branch of wood road, 28 feet east of brook in ravine, and about 75 feet north of where it is joined by a brook from the northeast. It is on line between the property of Mrs. Burnham and the Hostetter estate. This monument was found to be in good condition in every respect.

MONUMENT No. 360 — TOWN STONE 1.

Is a small monument with diagonal grooves, and stands upon a gentle easterly slope, on north edge of partially cleared land, alongside of a mass of fallen logs about 300 feet west of Loop's creek, and 1,196.6 feet east of monument No. 361. This monument marks the corner of the towns of Portville and Olean, Cattaraugus county, New York. It is on line between property of Dusenberry and Wheeler. This monument was found to be in good condition in every respect.

MONUMENT No. 361 — MILESTONE 155.

Is a small monument standing in thick open woods, on a steep easterly slope, about 600 feet east of the summit of the ridge west of Loop's creek valley. The trees in the vicinity of the monument are chiefly large beech. It is on line between property of Dusen-

berry and Wheeler. This monument was found to be in good condition in every respect.

MONUMENT No. 362 — MILESTONE 156.

Is a small monument standing in young growth of trees, on steep westerly slope, in a wet spot about 700 feet east of Meek's creek, 845 feet east of monument No. 363, 30 feet east of hemlock stump 25 feet high, and 20 feet east of upturned root. It is on line between the property of Wheeler and the South Pennsylvania Oil Company. This monument was found to be in good condition in every respect.

MONUMENT No. 363 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Denton's Mills to Haymaker. It is on line between the property of Wheeler and South Pennsylvania Oil Company. This monument has all its corners chipped, otherwise it was found to be in good condition in every respect.

MONUMENT No. 364 — MILESTONE 157.

Is a small monument standing on a narrow terrace, in thick open woods, about 175 feet northeast of the first oil derrick on the north side of the road nearest the summit, and about 225 feet east of the summit of the high ridge between Meeks and Indian creek, on general slope, quite steep, northeasterly, on property of South Pennsylvania Oil Company. This monument was found to be in good condition in every respect.

MONUMENT No. 365 — HIGHWAY STONE 1.

Is a highway monument standing on east side of a highway, along the east side of the east branch of Indian creek. It is on line between the property of A. W. Dodge and W. Mushrow. This monument has its south side chipped, otherwise it was found to be in good condition

MONUMENT No. 366 — MILESTONE 158.

Is a small monument standing in open woods, on a low bluff, steep southeasterly slope, to a brook in ravine flowing east-northeast, about 60 feet distant, about 1,200 feet west of the north branch

of Indian creek, and 1,593 feet west of monument No. 365. It is on line between the property of A. W. Dodge and A. A. Mushrow. This monument was found to be in good condition in every respect.

MONUMENT No. 367 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a road now but little used, leading north from the hamlet of Wigwam. It is on the property of Miles Loop. This monument has its southeast corner chipped and northwest corner broken, otherwise it was found to be in good condition.

MONUMENT No. 368 — TOWN STONE.

Is a small monument with diagonal grooves, standing near the top of a bluff, on a steep easterly slope, south of thick woods, 222 feet west of monument No. 367. It marks the corner of the towns of Otto and Eldred. It is on line between the property of H. Bulot and F. Newman. This monument was found to be in good condition in every respect.

MONUMENT No. 369 — MILESTONE 159.

Is a small monument standing in thick open woods, on a gentle southerly slope, in a clump of 10-inch hemlocks, about 350 feet north of road, 1,752.2 feet east of monument No. 370, and 200 feet northeast of derrick of Richard Rote. It is on line between the property of D. E. Quinlan and Lewis Loop's estate. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 370 — HIGHWAY STONE 1.

Is a highway monument standing on southwesterly side of highway, leading from Wigwam to Knapp's Creek station. It is on line between the property of D. E. Quinlan and Lewis Loop's estate. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 371 — MILESTONE 160.

Is a small monument standing in thick woods, upon a steep northeasterly slope, about 300 feet directly south of derrick No. 9, of the

Bradford Oil Company, 700 feet east of an immense rock, near the summit of the ridge and 1,333 feet east of monument No. 372. It is on the property of South Pennsylvania Oil Company. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 372 — HIGHWAY STONE 1.

Is a highway monument standing on northeasterly side of a highway leading from Knapp's Creek station to Dukes Center, on the summit of the ridge southwest of Indian creek. It is on the property of South Pennsylvania Oil Company. This monument has all corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 373 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of a road, leading from Knapp's Creek station to Moretown. It is on line between the property of Angel Oil Company and the Barse tract. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 374 — MILESTONE 161.

Is a small monument standing upon a steep westerly slope, cleared for oil purposes, and partially burned over, surrounded by bushes, 93.85 feet west of monument No. 393, and about 275 feet east of the middle branch of Knapp's creek. It is on line between the property of Angel Oil Company and Barse estate. This monument was found to be in good condition in every respect.

MONUMENT No. 375 — HIGHWAY STONE AND RAILROAD STONE.

Is a highway monument standing on west side of a highway leading from Duke's Center to State Line station, and on the east side of the track of the Western New York and Pennsylvania railroad (narrow gauge), and about 100 feet south from railroad depot. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 376 — HIGHWAY STONE 2.

Is a highway monument standing on east side of main road leading from Bradford to Olean, and 200 feet south of where road from State Line station intersects main road. It is on line between the property of Mrs. M. Smiley and William Meachin. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 377 — MILESTONE 162.

Is a small monument standing in woods and bushes on a gentle, southerly slope, about 100 feet northeast from derrick No. 5 of the South Pennsylvania Oil Company, and 490 feet west of Pembroke run. It is on line between property of Mrs. M. Smiley and South Pennsylvania Oil Company. This monument was found to be in good condition in every respect.

MONUMENT No. 378 — TOWN STONE.

Is a small monument with diagonal grooves standing in thick young woods, on a steep southeasterly slope, about 400 feet southeasterly from derrick No. 7, on the hill of the Angel Oil Company, and 2,354 feet west of monument No. 377. It makes the corner of the towns of Otto and Bradford, in McKean county, Pennsylvania. It is on line between the property of Angel Oil Company and E. T. Johnson. This monument was found to be in good condition in every respect.

MONUMENT No. 379 — MILESTONE 163.

Is a small monument standing in thick young woods on level ground southeast side of the summit of a ridge, north of the head of Chipmunk run, about 150 feet south of derrick No. 3, of J. T. Jones, and 300 feet south of the residence of M. P. Weaver. It is on line between the property of J. T. Jones and E. T. Johnson. This monument was found to be in good condition in every respect.

MONUMENT No. 380 — MILESTONE 164.

Is a small monument standing 7 chains 79 links east of the southwest corner of lot 1, section 13 of township 1, range 5, Holland

Land Company's purchase, in open space in woods, about 300 feet northwest of derrick No. 90, of W. O. Co., which is on south side and very close to Harrisburg run, in the middle of a large cove, looking directly north about 1 mile to the summit of a cove and 12 feet south of board and brush fence. It is on line between the property of Thomas Curwin and Franchott Brothers. This monument was found to be in good condition in every respect.

MONUMENT No. 381 — MILESTONE 165.

Is a small monument standing in a thick, open wood, on a small terrace, steep westerly slope, 888 feet west of the southeast corner of Carrollton, Cattaraugus county, New York, which is on the west side of the summit of high ridge on State Line run. It is on the property of Enterprise Transit Oil Company. This monument was found to be in good condition in every respect.

MONUMENT No. 382 — MILESTONE 166.

Is a highway monument standing in a narrow opening, cut out for a skidway in thick woods, 166 feet east of a small brook near the south side of State Line Run road which is now abandoned. It is on the property of the Enterprise Transit Oil Company. This monument was found to be in good condition in every respect.

MONUMENT No. 383 — HIGHWAY STONE 1.

Is a highway monument standing on north side of deserted State Line Run road, 12 feet south of line fence and about 700 feet east of monument No. 384. It is on line between the property of Beardsley and Booth. This monument has all its corners badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 384 — HIGHWAY STONE 2.

Is a highway monument standing on west side of road, in valley of Tuna creek, leading from Limestone into Bradford. It is on line between the property of Beardsley and Booth. This monument has its southeast and southwest corners chipped and has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 385 — RAILROAD STONE 1.

Is a small monument standing on east side of track of Buffalo, Rochester and Pittsburg railroad. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 386 — RAILROAD STONE 2.

Is a small monument standing on east side of track of the Bradford branch of the New York, Lake Erie and Western railroad. This monument has its edges chipped, and has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 387 — MILESTONE 167.

Is a small monument standing upon Tuna flats, on the southeast side of a narrow slough, about 200 feet east of Tuna Unguant creek, and 139 feet west of monument No. 386. This monument was found to be in good condition in every respect.

MONUMENT No. 388 — MILESTONE 167-1.

Is a small monument standing upon Tuna flats, at the east edge of the seventh latitude stone, on north side of line fence, and about 250 feet west of Tuna Unguant creek. This monument was found to be in good condition in every respect.

MONUMENT No. 389 — HIGHWAY STONE 1.

Is a highway monument standing on west side of road on the west side of valley of Tuna creek. It is on line between the property of William Beardsley and Phoebe Carpenter. This monument was found to be in good condition in every respect.

MONUMENT No. 390 — MILESTONE 168.

Is a small monument standing upon a little knoll, in a thick, young woods, on steep northeasterly slope, west side, at the head of a cove in the mountain, about 200 feet west of a brook, about 525 feet east of the narrow summit of the high ridge on west side of Tuna valley, and on south side of line barb-wire fence. It is on line between the property of William Beardsley and Freeley. This monument was found to be in good condition in every respect.

21

MONUMENT No. 391 — MILESTONE 169.

Is a small monument standing in thick open woods, upon a gentle southwesterly slope, on northeast side of a valley opening out upon Bolivar brook, about 100 feet west of where the hill begins to slope and about 865 feet west of the west side of the summit of the main ridge. It is on line between the property of Bingham estate and the Bradford Land Company. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 392 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of an abandoned wood road, which follows the valley of Bolivar brook. It is on line between the property of the Bingham estate and the Bradford Land Company. This monument has its northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 393 — MILESTONE 170.

Is a small monument standing in partially cleared space, in thick woods upon a very steep easterly slope, about 600 feet west of Bolivar brook, and 613.2 feet west of monument No. 392. It is on line between property of the Limestone Tannery Company and the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 394—HOLLAND LAND COMPANY'S PURCHASE.

Is a small monument with diagonal grooves and marks the corner of sections 54 and 66 of township 1, range 6, of Holland Land Company's Purchase, standing in thick open woods, on a gentle easterly slope 485 feet west of monument No. 393. It is on line between the property of the Limestone Tannery Company and the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 395 — HOLLAND LAND COMPANY'S PURCHASE AND TOWN STONE.

Is a small monument with diagonal grooves, set at the south end of the western transit meridian of the Holland Land Company's Purchase; it is standing in thick open woods, on nearly level ground,

5 feet west of large upturned root. It marks the corner of the towns of Carrollton and Red House, in Cattaraugus county, New York. It is on line between the property of the Limestone Tannery Company and the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 396 — MILESTONE 171.

Is a small monument standing in thick open woods (beech and maple) on level ground, 548.4 feet west of monument No. 395. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 397 — MILESTONE 172.

Is a small monument standing on gentle southeasterly slope, on east side of wood road, about 50 feet northwest of brow of steeper slope, southeast of Bennett brook. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 398 — HIGHWAY STONE 1.

Is a highway monument standing on east side of old Bradford Trail, now abandoned, 800 feet west of monument No. 397, and alongside of fallen log. It is on the property of the Bradford Land Company. This monument has its southwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 399 — HOLLAND LAND COMPANY'S PURCHASE.

Is a small monument with diagonal grooves, and marks the southwest corner of Willink strip. It stands in burnt woods, surrounded by briars, 60 feet south of Old Bradford Trail, and 1,539 feet west of monument No. 397. It is on line between the property of E. R. Schoonmaker and the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 400 — MILESTONE 173.

Is a small monument standing in burnt woods, on level ground, southwest of a gentle slope, and northwest to Red House creek and

about 1,000 feet south to an abandoned lumber camp on Red House creek, known as "Cass Duell's old shanties." It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 401 — HOLLAND LAND COMPANY'S PURCHASE, THREE-MILE POST.

Is a small monument standing on steep northerly slope, surrounded by rocks and fallen logs, 10 feet west of a small spring brook, about 350 feet southwest of deserted lumber camp, and 75 feet north of the brow of the hill. The letters "N. Y." and "Pa." were erroneously cut on the wrong sides of the stone. It stands upon the south line of township 1, range 7, of the Holland Land Company's Purchase, and about 260 feet west of the corner of sections 25 and 33 of township 1, range 7. It is on line between the property of the Bradford Land Company and the Stone estate. This monument was found to be in good condition in every respect.

MONUMENT No. 402 — MILESTONE 174.

Is a small monument standing on a northerly slope buried in the root and at the east side of a large windfall, 275 feet west of where the Allegany and Kinsua railroad crosses the line, 1,052 feet west of monument No. 401. It is on the property of the Bradford Land Company. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 403 — MILESTONE 175.

Is a small monument standing on a southerly slope 500 feet northeast of Yager's old saw mill, and about 300 feet north of Quaker Run, 12 feet south of road, which parallels the line running easterly, 1,555.2 feet east of monument No. 404 and about 1,072 feet east of the corner of sections 41 and 49, township 1, range 7, of the Holland Land Company's Purchase. It is on the property of the Bradford Land Company. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 404 — HIGHWAY STONE 1.

Is a highway monument standing on west side of an abandoned wood road, now grown up with briars, about 500 feet west of Yager's old saw mill and 60 feet northwest of north end of raised skidway. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 405 — MILESTONE 176.

Is a small monument standing on a very steep southerly slope, in thick woods, 300 feet south of the summit of the ridge, about 1,300 feet west of brow of slope, where it intersects the boundary line, 5 feet west of large fallen beech, and 268 feet west of the southeast corner of section 57, in township 1, range 7, of the Holland Land Company's Purchase. It is on the property of Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 406 — HOLLAND LAND COMPANY'S PURCHASE — MILEPOST 5½.

Is a small monument with diagonal grooves, standing in thick bushy woods, on narrow terrace, on steep southwesterly slope, about 200 feet from foot of slope, and 1,411 feet west of monument No. 405. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 407 — HIGHWAY STONE 1.

Is a highway monument standing on west side of road, leading northerly to Frecks, on south branch of Quaker run. It is on the property of the Bradford Land Company. This monument has all its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 408 — MILESTONE 177.

Is a small monument standing in thick open woods, on slight easterly slope, 455.6 feet west of monument No. 407, 6 feet south of a small brook, and 125 feet west of a clearing on the Pennsylvania side. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 409 — TOWN STONE 1.

Is a small monument with diagonal grooves, standing in open woods, steep, short northerly slope, south side of a narrow ravine, 10 feet east of a brook running westerly, 600 feet west of the summit of the ridge west of monument 408 and 2,753 feet east of monument No. 410. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 410 — MILESTONE 178.

Is a small monument standing on north edge of burnt slashing. covered with fallen logs and bushes, about 150 feet south of thick, open woods, on a steep northeasterly slope, 330 feet east of the summit of the ridge, east of valley of Wolf run, 167 feet west of large maple which stands on brow of very steep, northeasterly slope and 1,170 feet west of west branch of Quaker run. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 411 — MILESTONE 179.

Is a small monument standing in thick, open woods, on level ground, on north bank of shallow ravine, about 225 feet east of Wolf run and 968 feet east of highway monument on southwest side of Wolf Run road. It is on the property of the Bradford Land Company. This monument has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 412 — HIGHWAY STONE 1.

Is a highway monument standing on southwest side of road leading from Wolf run to Willow creek. It is on the property of the Bradford Land Company. This monument was found to be in good condition in every respect.

MONUMENT No. 413 — MILESTONE 180.

Is a small monument standing in thick, open woods, on steep northwesterly slope, 66 feet east of a brook in a deep ravine. It is on the property of the Bradford Land Company. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 414 — MILESTONE 181.

Is a small monument standing on the south edge of a large oak log, in thick, open woods, on a southeasterly slope, and 1,000 feet east of the brow of a steep, northwesterly slope. It is on line between the property of W. S. Weed & Co. and Bennis & Co. This monument was found to be in good condition in every respect.

MONUMENT No. 415 — MILESTONE 182.

Is a small monument standing in a small opening in thin, bushy woods on a steep southerly slope, north of Willow Creek valley, 1,742 feet east of a brook, in a deep ravine, and about 300 feet south of the summit of a ridge. It is on line between the property of Jay White and the Stone estate. This monument was found to be in good condition in every respect.

MONUMENT No. 416 — COUNTY STONE.

Is a small monument with diagonal grooves, standing in thick, young woods, on a steep southwesterly slope, 297 feet west of monument No. 415. This monument marks the corner of the counties of Warren and McKeen, Pennsylvania. It is on line between the property of Jay White and the Stone estate. This monument was found to be in good condition in every respect.

MONUMENT No. 417 — MILESTONE 183.

Is a small monument standing under line barb-wire fence, on north edge of clearing, on gentle southerly slope, and between two branches of Willow creek, one 800 feet east and the other 400 feet west. It is on line between the property of John Warren and Perry Root. This monument was found to be in good condition in every respect.

MONUMENT No. 418 — HIGHWAY STONE 1.

Is a highway monument standing on east side of a road leading northerly from Corydon, about 100 feet north of John T. Odell's house. It is on line between the property of John T. Odell and the Genung estate. This monument has its northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 419 — ALLEGANY INDIAN MONUMENT.

Is an iron monument standing 1,783.25 feet west of monument No. 417, in the middle of the road leading from Corydon to Wolf run, standing out of the ground about 6 inches; and 15 feet west of monument No. 418, and is 6½ inches south of line. It was set by United States Commission in 1878, to mark the southeast corner of the Allegany Indian reservation. It is on line between the property of John Warren and Perry Root. This monument was found to be in good condition in every respect.

MONUMENT No. 420 — RAILROAD STONE 1.

Is a small monument standing on the east side and 15 feet distant therefrom of the Western New York and Pennsylvania Railroad Company's track center. This monument has its south side badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 421 — MILESTONE 184.

Is a small monument standing in cleared, cultivated land, on south side of stump fence, about 50 feet west from the north end of worm fence and 570.3 feet east of monument No. 422. It is on line between the property of the Allegany Indian reservation and Daniel Root. This monument was found to be in good condition in every respect.

MONUMENT No. 422 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of the river road leading from Corydon to the Indian reservation. It is on line between the property of Allegany Indian reservation and Daniel Root. This monument was found to be in good condition in every respect.

MONUMENT No. 423 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of the road on the right-hand bank of the Allegany river. It is on line between the property of the Allegany Indian reservation and J. K. Webb. This monument was found to be in good condition in every respect.

MONUMENT No. 424 — MILESTONE 185.

Is a small monument standing in a small cleared spot, in thick, bushy pasture, on a northeasterly slope, south of thick woods, 290 feet west of a small brook, in a shallow ravine, and just north of a very steep northerly slope, nearly 500 feet south of State Line run, under line barb-wire fence. It is on line between the property of the Allegany Indian reservation and J. K. Webb. This monument has its southeast corner broken, otherwise it was found to be in good condition.

MONUMENT No. 425 — ALLEGANY INDIAN MONUMENT.

Is an iron monument about 18 inches high, standing 294.4 feet west of monument No. 424, upon a gentle easterly slope, in a thick growth of briars, south side of a large hemlock stump. It was placed in 1878 to mark the southwest corner of the Indian reservation. It is on line between the property of the Indian reservation and J. K. Webb. This monument was found to be in good condition in every respect.

MONUMENT No. 426 — REFERENCE MONUMENT 1.

Is a highway monument standing at the side of monument No. 425, just south of the brow of steep northerly slope, towards State Line run, about 500 feet south of the run. It is on line between the property of the Indian Reservation and J. K. Webb. This monument was found to be in good condition in every respect.

MONUMENT No. 427 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway, leading southwesterly from State Line Run road. It is on line between the property of Sylvester Birch and Munsen Bliss. This monument has all corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 428 — MILESTONE 186.

Is a highway monument on the west side of State Line run road, 35 feet north of creek, and at point where State Line Run road runs southerly into Pennsylvania, in cleared land, under fence which runs north and south. It is on line between the property of Syl-

vester Birch and Munsen Bliss. This monument has its corners chipped and has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 429 — MILESTONE 187.

Is a small monument standing on steep southerly slope, in woods grown up to bushes and briars, about 50 feet east of abandoned wood road, running northwest, 850 feet east of monument No. 430, and 500 feet north of State Line run. It is on line between the property of Hiram Scott and Thomas Quamtanto. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 430 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of a wood road, about 300 feet north of State Line run. It is on the property of Hiram Scott. This monument was found to be in good condition in every respect.

MONUMENT No. 431 — HIGHWAY STONE 2, SECTION STONE.

Is a highway monument standing in a shallow ravine, 1,014 feet east of monument No. 432, 40 feet south of wood road, and about 100 feet west of abandoned wood road running southerly. It marks the corner of sections 34 and 49 of township 1, range 9 of the Holland Land Company's Purchase. It is on line between the property of Voley Vickery and J. M. Wilson. This monument was found to be in good condition in every respect.

MONUMENT No. 433 — TOWN STONE 1.

Is a small monument with diagonal grooves, standing on a slight easterly slope, on east side of summit of Robbins' hill, in open field, 292.3 feet east of monument No. 434, on north side of worm line fence and 15 feet east of fence running southerly. It marks the corner of the townships of Elk and Pine Grove, in Warren county, Pennsylvania. It is on line between the property of Burt and Williams. This monument was found to be in good condition in every respect.

MONUMENT No. 434 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of Quaker Hill road, leading from South Valley to Ackley. It is on line between the property of William Robbins and S. L. Burt. This monument was found to be in good condition in every respect.

MONUMENT No. 435 — MILESTONE 189.

Is a small monument standing on a westerly slope, in cleared land, about 5 feet northwest of a large burnt stump, and 90 feet west of wood road, and 730.3 feet west of monument No. 434, and about 100 feet west of the southeast corner of clearing. It is on the property of S. L. Burt. This monument was found to be in good condition in every respect.

MONUMENT No. 436 — COUNTY STONE.

Is a highway monument standing in cleared land on southerly slope, at junction of State line and county line fences, 1,380.1 feet west of monument No. 435. It marks the corner of the counties of Cattaraugus and Chautauqua, New York. It is on line between the property of William Robbins and F. Burke. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 437 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a highway leading from the county line of Cattaraugus and Chautauqua to Ackley. It is on line between the property of Davis and Bullock. This monument has all corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 438 — MILESTONE 190.

Is a small monument standing on nearly level ground, in a small narrow gully, covered with briars and fallen trees, about 5 feet south of north branch of brook which flows westerly, north edge of clearing, under line barb wire fence and at junction of wire fence running northerly, north 1 degree 30 minutes east, and about one-fourth of a mile from the residence of W. F. Atkins. It is on line between the property of W. Wilson and W. F. Atkins. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 439 — HIGHWAY STONE 1 AND SECTION STONE.

Is a highway monument standing about 15 feet east of the road leading from Frewsburg to Ackley station, and about 30 feet south of Riverside creamery. It marks the corner of sections 9 and 17 in township 1 range 10 of the Holland Land Company's Purchase. It is on line between the property of William Colliton, C. Cole, G. G. Anderson and E. E. Herrick. This monument was found to be in good condition in every respect.

MONUMENT No. 440 — MILESTONE 191.

Is a small monument standing in cleared land, north of a piece of woods, upon a southeasterly slope, under line worm fence, 1,635 feet west of monument No. 439. It is on line between the property of William Colliton and G. G. Anderson. This monument was found to be in good condition in every respect.

MONUMENT No. 441 — FOUR-MILE POST, HOLLAND LAND COMPANY'S PURCHASE.

Is a small monument standing upon a steep bluff, on the west side of a deep ravine, 100 feet west of brook, on south side of line fence, and 1,107.5 feet west of monument No. 440. It is on the property of John Lundburg. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 442 — MILESTONE 192.

Is a small monument standing in an open chestnut grove, south side of thick woods, on a westerly slope, southeast side of small ravine, 3 feet south of line fence, and 395 feet west of the summit of a ridge, west side of a deep ravine. It is on line between the property of A. H. Lake and Harrison Fenton. This monument was found to be in good condition in every respect.

MONUMENT No. 443 — HIGHWAY STONE 1.

Is a highway monument on the east side of road leading from Pine Grove to Fentonville. It is on line between the property of Richardson and Mrs. Noyce. This monument was found to be in good condition in every respect.

MONUMENT No. 444 — MILESTONE 193.

Is a small monument standing on a narrow gravel ridge, between two small swamps, on Conewango flats, on north side of line stump fence and about 150 feet east from west end of fence. It is on the property of Woodruff Allen. This monument was found to be in good condition in every respect.

MONUMENT No. 445 — RAILROAD STONE 1.

Is a small monument standing on the west side of the Dunkirk, Allegany Valley and Pittsburg railroad. It was found to be in good condition in every respect.

MONUMENT No. 446 — RIVER STONE 1.

Is a small monument standing on the left hand bank of the Conewango river, in cleared land, under board fence, and 30 feet east of the bank of the river. It is on the property of Martha Allen. This monument was found to be nearly flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 447 — RIVER STONE 2 AND HIGHWAY STONE 1.

Is a highway monument standing on the west bank of the Conewango river, on the north side of an abandoned road, and about 40 feet west of the river. It is on line between the property of H. Cox and Charles Durand. This monument was found to be in good condition in every respect.

MONUMENT No. 448 — MILESTONE 194.

Is a small monument standing on the west side of a road, leading from Jamestown, New York to Warren, Pennsylvania, about 3,575 feet west of the Conewango river, and 125 feet southerly from the residence of Henry Cox. It is on line between the property of Henry Cox and G. Townsend. This monument was found to be in good condition in every respect. A large sandstone monument set by A. T. Pendergrast, in 1871, stands at the west edge of milestone 194.

MONUMENT No. 449 — MILESTONE 195 AND TOWN STONE.

Is a small monument with diagonal grooves, standing in cleared field, 5 feet south of line fence, and 367.6 feet east of monument No. 450. It marks the corner of the towns of Pine Grove and Farmington, in Warren county, Pennsylvania. It is on the property of William Townsend. This monument has heaved 3 inches, and has its south side chipped, otherwise it was found to be in good condition.

MONUMENT No. 450 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of a road leading from Kiantone to Russell. It is on the property of William Townsend. This monument has its north side broken, otherwise it was found to be in good condition.

MONUMENT No. 451 — MILESTONE 195 1-8.

Is a small monument standing at the east edge of the eighth latitude stone, on the north edge of thick woods, and the west brow of a narrow ravine, just south of rail and bush fence. It is on line between the property of Brewster and William Townsend. This monument was found to be in good condition in every respect.

MONUMENT No. 452 — MILESTONE 196.

Is a small monument standing on a gentle northerly slope, north side of thick woods, and about 50 feet east of an abandoned wood road, about 500 feet east of the southwest corner of a clearing, and about 800 feet southwest of the residence of Standish. It is on line between the property of Robert Jackson and J. Standish. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 453 — MILESTONE 197.

Is a highway monument standing on cleared land, on gentle northerly slope, 30 feet east of a road, leading from Farmington to Jamestown. It is on the property of T. Gustafson. This monument was found to be in good condition in every respect.

MONUMENT No. 454 — HIGHWAY STONE 1 AND TOWN STONE.

Is a highway monument standing on the east side of a road, leading from Warren to Jamestown, about 60 feet south of small brook crossing road. It marks the corner of the towns of Kiantone and Busti, New York. It is on the property of Martin Beck. This monument has its west edge chipped, otherwise it was found to be in good condition.

MONUMENT No. 455 — MILESTONE 198.

Is a small monument standing on level ground, on the north side of a clearing, in the edge of woods, 705.3 feet west of monument No. 454, and on the north side of worm fence. It is on the property of Jasper Cole. This monument was found to be in good condition in every respect.

MONUMENT No. 456 — HOLLAND LAND COMPANY'S PURCHASE, 2½-MILE POST.

Is a small monument standing in open woods, on a westerly slope, about 300 feet west of the summit of the ridge, and 2,475 feet west of monument No. 455, and under line worm fence. It marks the 2½-mile post of the Holland Land Company's Purchase; it is on the south line of township 1, range 11. It is on the property of Jasper Coles. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 457 — MILESTONE 199.

Is a highway monument standing on the west side of a road, leading from Jamestown to Warren. It is on line between the property of H. A. Nelson and L. A. Coleman. This monument has its north and south sides chipped, otherwise it was found to be in good condition.

MONUMENT No. 458 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of a road leading from Busti to Warren. It is on line between the property of W. Stanford and W. H. Holcomb. This monument was found to be in good condition in every respect.

MONUMENT No. 459 — MILESTONE 200.

Is a small monument standing under line worm fence, on the south edge of woods, on southerly slope, north of a ravine at the corner of two Pennsylvania farms, which is also the corner of Pennsylvania Warrants Nos. 242 and 291; about 100 feet east of the head of a long westerly slope. It is on line between the property of W. H. Holcomb and W. Stanton. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 460 — TOWN STONE.

Is a small monument standing on level ground in a little cove on a low bluff, which slopes southerly 13 feet south of foot of slope, about 2,500 feet west of monument No. 459, and under line worm fence. It marks the corner of the townships of Sugar Grove and Farmington, Pennsylvania. It is on line between the property of H. Paige and W. Stanton. This monument was found to be in good condition in every respect.

MONUMENT No. 461 — MILESTONE 201.

Is a highway monument standing on the west side of a road, east of Stillwater creek, leading from Busti to Chandler's Valley. It is on line between the property of Stanford and Simmons. This monument has all corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 462 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of stage road, leading from Jamestown to Sugar Grove. It is on line between the property of W. Weld and the Ricker estate. This monument was found to be in good condition in every respect.

MONUMENT No. 463 — MILESTONE 202.

Is a small monument standing in an open field, north of a garden in orchard, on easterly slope, 241.35 feet west of monument No. 462. It is on line between the property of William Weld and the Ricker estate. This monument was found to be in good condition in every respect.

MONUMENT No. 464 — MILESTONE 203.

Is a small monument standing in thick woods, on nearly level ground, 205 feet west of the southeast corner of J. Boswell's farm, about 500 feet east of brook in deep ravine, about 2,083 feet east of monument No. 465, and on north side of line worm fence. It is on line between the property of the Boswell estate and S. Barnett. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 465 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Jamestown to Sugar Grove. It is on line between the property of the Boswell estate and S. Barnett. This monument was found to be in good condition in every respect.

MONUMENT No. 466 — MILESTONE 204.

Is a small monument standing at the corner of Pennsylvania Warrants 243 and 244, on north edge of thick open woods, about 15 feet east of the southwest corner of a clearing, 75 feet east of brook flowing northerly in shallow ravine, and 3 feet north of line worm fence. It is on line between the property of Birklain and Catlin. This monument has all corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 467 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a highway leading from Meadville to Sugar Grove. It is on line between the property of S. M. Seabury and J. Toolfire. This monument was found to be in good condition in every respect.

MONUMENT No. 468 — MILESTONE 205.

Is a small monument standing at the corner of Pennsylvania Warrants 193 and 243, on a gentle slope westerly, in open woods, 360 feet west of a brook, flowing southerly in shallow ravine, about 2,404 feet east of monument No. 469, and at the junction of a board and worm fence. It is on line between the property of Madison and Lopes. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 469 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of highway, leading from Ashville to Sugar Grove. It is on line between the property of Madison and Lopes. This monument was found to be in good condition in every respect.

MONUMENT No. 470—MILESTONE 206 AND TOWN STONE.

Is a small monument with diagonal grooves, standing in cleared land on northeasterly slope, north of a thin piece of wood, about 200 feet west of the west end of worm line fence. It marks the corner of the townships of Sugar Grove and Freehold, in Warren county, Pennsylvania. It is on line between the property of William Gates and C. Lopes. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 471 — HIGHWAY STONE 1.

Is a highway monument standing on the east side of highway, leading from Stillwater to Watts' Flats. It is on line between the property of Spooner and Bindley. This monument was found to be in good condition in every respect.

MONUMENT No. 472 — MILESTONE 207.

Is a small monument standing at the corner of Pennsylvania Warrants Nos. 192 and 187, at the northwest corner of a triangular piece of woods, upon nearly level ground, at the junction of two worm fences, 490.3 feet west of monument No. 471, and 3 feet south of line worm fence. It is on line between the property of David Spooner and C. S. Woodburn. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 473 — MILESTONE 208.

Is a small monument standing on level ground, in thick open woods, 10 feet west of top of bluff, on the west bank of a hollow ravine about 45 feet west of Deer Lick creek, and 462 feet east of same creek, where it again crosses boundary flowing southwesterly, and at west end of barb-wire fence, where it is joined by fence running southerly. It is on line between the property of Cross and Allen. This monument was found to be in good condition in every respect.

MONUMENT No. 474 — HIGHWAY STONE 1.

Is a highway monument standing on east side of a road leading from Wrightsville to Mayville. It is on line between the property of Effie A. Cross and DeWitt Allen. This monument has its corners badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 475 — MILESTONE 209.

Is a small monument standing in level cleared land, 30 feet west of the right bank of Little Broken Straw creek, about 3 feet north of worm fence, and 6 feet west of north end of board fence. It is on line between the property of Aaron Cornish and H. Crouse. This monument was found to be in good condition in every respect.

MONUMENT No. 476 — HIGHWAY STONE 1.

Is a highway monument standing on east side of road leading from Panama to Lottsville. It is on line between the property of Aaron Cornish and J. Ness. This monument was found to be in good condition in every respect.

MONUMENT No. 477 — RAILROAD STONE 1.

Is a small monument standing on an embankment of the New York, Pennsylvania and Ohio railroad, 986 feet east of monument No. 478. This monument was found to be in good condition in every respect.

MONUMENT No. 478 — MILESTONE 210.

Is a small monument standing 986.7 feet east of monument No. 477, in an open space in woods, on a low knoll, in a swamp, on north side of brush line fence, and at corner of Pennsylvania brush fence, about 22 feet south of large hemlock stump, about 3 feet high, which shows witness hacks. It is on line between the property of Aaron Cornish and William Robinson. This monument was found to be in good condition in every respect.

MONUMENT No. 479 — HIGHWAY STONE 1.

Is a highway monument standing on west side of road leading from Lottsville to Panama. It is on line between the property of Chapman and Mrs. Morgan. This monument was found to be in good condition in every respect.

MONUMENT No. 480 — MILESTONE 211.

Is a small monument standing in cleared land, on southwest slope, about 150 feet east of brook in shallow ravine, and at north end of fence, which indicates the line between Pennsylvania Warrants 103 and 392, and about 2,000 feet east of a large boulder, with a cross upon its top, standing in cleared field, under and at the end of New York board line fence. The cross on the boulder marks the line between sections 41 and 49, in township 1, range 13, of the Holland Land Company's Purchase. It is on line between the property of James Hartson and P. Cooper. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 481 — HIGHWAY STONE 1.

Is a highway monument standing on east side of a road leading from Bear Lake to Panama. It is on line between the property of J. Bordwell and James Hartshorn. This monument was found to be in good condition in every respect.

MONUMENT No. 482 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of a highway, leading from Panama to Corry. It is on line between the property of H. Howard and James Hartshorn. This monument has heaved 8 inches, otherwise it was found to be in good condition.

MONUMENT No. 483 — MILESTONE 212 AND TOWN STONE.

Is a small monument with diagonal grooves, standing on level ground at north edge of line fence, and at north end of Pennsylvania fence in woods near the northeast corner of a partial clearing, about 750 feet east of a brook, and 1,017 feet west of monument No. 482. It marks the corner of the towns of Freehold and Columbus, in Warren county, Pennsylvania. It is on line between the property of H. Howard and James Hartshorn. This monument was found to be in good condition in every respect.

MONUMENT No. 484. — HIGHWAY STONE 1.

Is a highway monument standing on the east side of a road, leading from Kings Corners to Bear Lake, opposite the residence of

Alfred Whipple. It is on the property of Alfred Whipple. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 485 — MILESTONE 213.

Is a small monument standing in open cultivated land, on south side of boundary line road, on gentle westerly slope, 738 feet west of monument No. 484, and about 150 feet east of a 6-inch cherry tree. It is on the property of Alfred Whipple. This monument has its top three inches above the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 486 — HIGHWAY STONE 1.

Is a highway monument standing on south side of boundary line road, at its junction with road leading to Columbus. It is on line between property of Alfred Whipple and B. Chadwick. This monument was found to be in good condition in every respect.

MONUMENT No. 487 — MILESTONE 214.

Is a highway monument standing in level cleared field, on north side of boundary line road, about 80 feet west of a small brook, and north of a line fence. It is on the property of B. Chadwick. This monument was found to be in good condition in every respect.

MONUMENT No. 488 — HIGHWAY STONE 1.

Is a highway monument standing at the west end of boundary line road, at its junction with road leading to Columbus and 458.8 feet west of monument No. 487. It is on the property of B. Chadwick. This monument was found to be in good condition in every respect.

MONUMENT No. 489 — HIGHWAY STONE 2.

Is a highway monument standing on the southwest side of a road leading to Clymer Station, at end of barb wire fence. It is on line between the property of S. Barber and C. Cooley. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 490 — MILESTONE 215.

Is a small monument standing in open woods, upon rolling land, on gentle easterly slope, about 30 feet east of brow of a deep ravine, and about 1,221 feet west of monument No. 489. It is on line between the property of S. Cooley and Ewers. This monument was found to be in good condition in every respect.

MONUMENT No. 491 — HIGHWAY STONE 1 AND SECTION STONE.

Is a highway monument standing in level wet ground, at south edge of thick woods, near the northeast corner of a clearing, at the southeast end of a road laid out and cut through the woods, but now abandoned, and at the east end of line fence. It marks the corners of sections 17 and 25 in township 1, range 14 of the Holland Land Company's Purchase. It is on line between the property of Cooley and Ewers. This monument was found to have its southwest corner slightly chipped, otherwise in good condition.

MONUMENT No. 492 — MILESTONE 216.

Is a small monument standing in an open field, on a westerly slope, on south side of line fence, 747.7 feet east of monument No. 493. It is on line between the property of Cooley and Walton. This monument was found to be in good condition in every respect.

MONUMENT No. 493 — HIGHWAY STONE 1.

Is a highway monument standing on east side of boundary line road, at its junction with road running from Columbus to Clymer Station. It is on line between the property of S. Cooley and C. Walton. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 494 — MILESTONE 217.

Is a highway monument standing on the north side of boundary line road, about 750 feet west of the west side of the summit of the ridge east of Broken Straw creek. It is on line between the property of Brown and Gillett. This monument has its northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 495 — COUNTY STONE.

Is a highway monument standing on the north side of boundary line road, upon a westerly slope, 48 feet west of a large maple, and 462.6 feet west of monument No. 494. It marks the corner of the counties of Warren and Erie, Pennsylvania. It is on line between the property of Gillett and King. This monument was found to be in good condition in every respect.

MONUMENT No. 496 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of boundary line road. It is on the property of William Brown. This monument was found to be in good condition in every respect.

MONUMENT No. 497 — RAILROAD STONE 1.

Is a small monument standing on west side of Western New York and Pennsylvania railroad track, and about 30 feet west of the same. This monument has its top 3 inches above the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 498 — HIGHWAY STONE 2.

Is a highway monument standing on the east side of a road, leading from Columbus to Clymer. It is on the property of Michael McFarlin. This monument has its northwest and its southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 499 — MILESTONE 218.

Is a small monument standing in a maple grove, on south side of line fence, north of an orchard, on a northeasterly slope, and 786.6 feet west of monument No. 498. It is on the property of M. McFarlin. This monument was found to be in good condition in every respect.

MONUMENT No. 500 — HOLLAND LAND COMPANY'S PURCHASE. SECTION STONE.

Is a small monument with diagonal grooves, standing midway upon a very steep northwesterly slope, on the southeast side of a deep ravine, in a bushy piece of woods. It marks the corner

of sections 49 and 57, in township 1, range 14, of the Holland Land Company's purchase. It is on the property of Michael McFarlin. This monument was found to be in good condition in every respect.

MONUMENT No. 501 — HIGHWAY STONE 1.

Is a highway monument standing on north side of and at east end of boundary line road. It is on the property of Michael McFarlan. This monument was found to be in good condition in every respect.

MONUMENT No. 502 — HIGHWAY STONE 2.

Is a highway monument standing on the north side of boundary line road at the junction of road running southerly to Corry. It is in front of the residence of George Beebe and W. Lictus. This monument was found to be in good condition in every respect.

MONUMENT No. 503 — TOWN STONE.

Is a highway monument standing on the north side of boundary line road. It marks the corner of the towns of French Creek and Clymer, in Chautauqua county, New York. It is about 250 feet west of a brook in a deep ravine. It is on the property of D. Howells. This monument was found to be in good condition in every respect.

MONUMENT No. 504 — MILESTONE 219.

Is a highway monument standing on the north edge of wagon track, of boundary line road, upon level ground, upon second summit, west of Big Broken Straw valley, and about 700 feet west of monument No. 503. It is on the property of D. Howells. This monument was found to be in good condition in every respect.

MONUMENT No. 505 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, at junction with road running southerly to Corry. It is on line between the property of John Rickers and D. Howells. This monument was found to be in good condition in every respect.

MONUMENT No. 506 — HOLLAND LAND COMPANY'S PURCHASE STONE, MILEPOST 5½.

Is a highway monument standing on the north side of boundary line road, about 1,000 feet west of monument No. 505. It is on the property of John Rickers. This monument was found to be in good condition in every respect.

MONUMENT No. 507 — HIGHWAY STONE 2.

Is a highway monument standing on the north side of boundary line road at junction of road running northerly to Clymer. It is on line between the property of H. Haybink and John Rickers. This monument has its northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 508 — MILESTONE 220.

Is a highway monument standing on the north side of boundary line road, upon the east slope of the second knoll, west of a deep ravine east of the valley of Hare creek. It is on the property of H. Haybink. This monument was found to be in good condition in every respect.

MONUMENT No. 509 — HIGHWAY STONE 1.

Is a highway monument standing at west end of boundary line road. It is on line between the property of B. P. Condon and Barney Raymond. This monument was found to be in good condition in every respect.

MONUMENT No. 510 — MILESTONE 221.

Is a highway monument standing on the south edge of woods, west of a ravine, on the north side of boundary line road, and at west end above the summit of a steep, easterly slope. It is on line between the property of Austin and Condon. This monument was found to be in good condition in every respect.

MONUMENT No. 511 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, at junction of road leading southerly to Corry. It is on the property of school district No. 3. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 512 — MILESTONE 222.

Is a highway monument standing on the north side of boundary line road, 760.6 feet west of monument No. 511, on cultivated land, on westerly slope. It is on line between the property of Lloyd and Howard. This monument has heaved six inches, and inclines to the west, otherwise it was found to be in good condition.

MONUMENT No. 513 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, about 50 feet west of where bridge crosses stream, at its junction with road running northwesterly. It is on line between the property of Gensling and Weizer. This monument has heaved three inches, otherwise it was found to be in good condition.

MONUMENT No. 514 — MILESTONE 223.

Is a highway monument standing on the north side of boundary line road, on south edge of thick woods, on easterly slope, a short distance east of the summit of the ridge, between two branches of Herrick creek, 397.8 feet west of monument No. 513. It is on line between the property of Gensling and Weizer. This monument was found to be in good condition in every respect.

MONUMENT No. 515 — HIGHWAY STONE 1.

Is a highway monument standing in wagon track of boundary line road in the meridian of astronomical station "Clark," 69.32 feet north from center of station, and about 984 feet east of monument No. 516. It is on line between the property of L. B. Clark and Reynolds. This monument is set flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 516 — MILESTONE 224.

Is a highway monument standing on the north side of boundary line road, upon the second summit, east of the valley of French creek, and about 150 feet southeast of the residence of Mrs. Clark. It is on line between the property of Mrs. Clark and L. D. Moore. This monument has heaved 6 inches, and leans to the north, otherwise it was found to be in good condition.

MONUMENT No. 517 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, at junction with road running southerly to Carter Hill. It is on line between the property of D. Marts and Ottoway estate. This monument has its south side chipped, otherwise it was found to be in good condition.

MONUMENT No. 518 — TOWN STONE.

Is a highway monument standing on the north side of wagon track of boundary line road, on a steep westerly slope, 376.3 feet east of the monument at the southwest corner of New York. It marks the corner of the townships of Wayne and Amity, in Erie county, Pennsylvania. It is on line between the property of Simmons and Bisbee. This monument has its top flush with the surface of the ground, otherwise it was found to bein good condition.

MONUMENT No. 519 — CORNER STONE.

Is a small monument with diagonal grooves, standing in the wagon track of the boundary line road, upon level ground, at the foot of a long westerly slope, east of the valley of French creek, about 4,496 feet west of milestone 224, and 825 feet east of the probable position of original milestone No. 225. It is 20 feet south of monument No. 1, standing on the north side of boundary line road, and 98.5 feet south of the south side of the base of the large initial monument standing in the meridian boundary. It is set at the intersection of the parallel and meridian boundary and marks the southwest corner of New York. It is on line between the property of Bennett and Simmons. This monument has all its corners chipped, otherwise it was found to be in good condition.

MERIDIAN BOUNDARY.

The monuments on this boundary are similar in all respects to those on the parallel boundary. They are marked on the east side "N. Y." and on the west side "Pa." None of the fourth and fifth classes was set. The milestones which are not highway monuments, with one exception, are marked with the appropriate number on the north face.

MONUMENT No. 1 — HIGHWAY MONUMENT.

Is a highway monument standing on the north side of road which follows the parallel boundary. It is on line between the property of Simmons and Bennett. This monument was found to be in good condition in every respect.

MONUMENT No. 2 — LARGE REFERENCE MONUMENT.

Is a large block of Rhode Island granite, similar in all respects to the large initial monument on the right hand bank of the Delaware river, except that its east and west faces are marked "100 feet north of the southwest corner of New York." It stands on level ground in cleared field, on the east side of line fence, and in the meridian of the corner monument, which is 98.5 feet south from the south side of its base. It is on line between the property of Simmons and Bennett. This monument was found to be in good condition in every respect.

MONUMENT No. 3 — MILESTONE 18.

Is a small monument standing on the east edge of clearing, in level ground, just north of thick, open woods, 7 feet west of line fence, 3,520 feet north of the monument at the southwest corner. It is on line between the property of the Sweet estate and Charles Black. This monument was found to be in good condition in every respect.

MONUMENT No. 4 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of a road, leading from Wattsburg to Jamestown. It is on line between the property of the Sweet estate and F. M. Foote. This monument was found to be in good condition in every respect.

MONUMENT NO. 5 — MILESTONE 17.

Is a small monument standing on the south edge of thick, open woods, 135 feet south of the summit of the ridge, 50 feet north of the top of a steep bluff, north side of the valley of the east branch of French creek, and about 1,300 feet north of creek. It is on line between the property of F. M. Foote and McGill. This monument was found to be in good condition in every respect.

MONUMENT No. 6 — HOLLAND LAND COMPANY'S PURCHASE, MILEPOST 2.

Is a small monument standing on the southwest side of a short, narrow ravine, crossing the line towards the southeast, on a steep northeast slope, in thick open woods, 1,794 feet north of monument No. 5. It is on line between the property of F. M. Foote and Henry Goethen. This monument was found to be in good condition in every respect.

MONUMENT No. 7 — MILESTONE 16.

Is a small monument standing 1,574 feet south of monument No. 8, on a narrow terrace near the bottom of a northeasterly bank, of a narrow ravine, about 600 feet northwest of where the creek branches to the northeast, 9 feet east of boulder, which lies on east bank of brook which flows southeasterly, and about 60 feet south of south end of line barb-wire fence. It is on line between the property of J. Gilmore and J. Hadley. This monument was found to be in good condition in every respect.

MONUMENT No. 8 — HIGHWAY STONE 1.

Is a highway monument standing on the south side of road leading from Wattsburg to Clymer. It is on line between the property of J. Gilmore and J. Hadley. This monument was found to have all its corners chipped.

MONUMENT No. 9 — HOLLAND LAND COMPANY'S PURCHASE, MILEPOST 3 1-2.

Is a small monument standing on the east edge of a meadow a short distance south of a deep ravine, and 245.5 feet north of monument No. 8. It is on line between the property of J. Gilmore and J. Hadley. This monument was found to be in good condition in every respect.

MONUMENT No. 10 — HOLLAND LAND COMPANY'S PURCHASE, MILEPOST 3.

Is a small monument in thick, open woods, upon level ground just at the brow of a short, westerly slope, 744.5 feet south of monument No. 11. It is on line between the property of J. Gilmore

and J. Hadley: This monument has its south corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 11 — MILESTONE 15.

Is a small monument standing on level ground, in the bottom of a deep ravine, in thick, open woods, about 6 feet from the foot of the south bluff, and 25 feet south of the channel of a brook flowing westerly. It is on line between the property of Gilmore and Hadley. This monument was found to be in good condition in every respect.

MONUMENT No. 12 — HOLLAND COMPANY'S PURCHASE, MILEPOST 4 1-2.

Is a small monument standing on level ground thickly covered with bushes and fallen trees, 742.8 feet south of monument No. 13. It is on line between the property of Dugan and King. This monument was found to be in good condition in every respect.

MONUMENT No. 13 — MILESTONE 14.

Is a small monument standing upon level ground thickly covered with briars, bushes and fallen logs, 30 feet north and 30 feet east from channel of brook, which flows northwesterly and on ground about 5 feet higher than brook. It is on line between the property of Dugan and King. This monument was found to be in good condition in every respect.

MONUMENT No. 14 — MILESTONE 13.

Is a small monument standing 1,940 feet south of monument No. 15, upon the brink of the southeast bank of a narrow ravine, about 20 feet deep, in partially cleared land on north side of post in barb-wire fence. The figures "13 M." were erroneously cut on the south face of the stone. It is on line between the property of ——— and ———. This monument was found to be in good condition in every respect.

MONUMENT No. 15—HIGHWAY STONE AND TOWN STONE.

Is a highway monument standing on north side of road, leading into Pennsylvania. It marks the corner of the townships of Venango and Greenfield, in Erie county, Pennsylvania, and towns of

Mina and French creek, Chautauqua county, New York. It is on the property of ———. This monument was found to be in good condition in every respect.

MONUMENT No. 16 — HIGHWAY MONUMENT 2.

Is a highway monument standing on the north side of a highway, running southeasterly, about 15 feet east of brook, in shallow ravine. It is on the property of ———. This monument was found to be in good condition in every respect.

MONUMENT No. 17 — MILESTONE 12.

Is a small monument standing in cultivated land, on a narrow knoll, north of a shallow ravine, 208.5 feet north of monument No. 16. This monument was found to be in good condition in every respect.

MONUMENT No. 18 — HIGHWAY STONE 1.

Is a highway monument standing on west side of a short piece of boundary line road, just where it turns to the southwest into Pennsylvania. It is on line between the property of Franklin Haskins and Nehemiah Lathrop. It was found to be in good condition in every respect.

MONUMENT No. 19 — HIGHWAY STONE 2.

Is a highway monument standing on west side of boundary line road, just where it turns easterly into New York. It is on line between the property of Franklin Haskins and Nehemiah Lathrop. This monument was found to be in good condition in every respect.

MONUMENT No. 20 — MILESTONE 11.

Is a small monument standing in level meadow land, 781 feet north of monument No. 19, and about 200 feet east of Alvira Lewis' barn, and 15 feet west of line worm fence. It is on line between the property of Alvira Lewis and Nehemiah Lathrop. This monument was found to be in good condition in every respect.

MONUMENT No. 21 — HIGHWAY STONE 1.

Is a highway monument standing on the north side of a road leading easterly to Findlay's lake. It is on the property of Joseph Rockwell. This monument was found to have heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 22 — MILESTONE 10.

Is a small monument standing upon a terrace, on a steep southwesterly side of a deep ravine, 487.8 feet south of a large hemlock with "NXIII" cut on it, and is supposed to indicate the southeast corner of Warrant No. 13, in the township of Greenfield, Pennsylvania, about 2,000 feet north of monument No. 21, and about 20 feet west of line barb-wire fence, and 40 feet south of where the creek crosses the line. It is on the property of Joseph Rockwell. This monument was found to be in good condition in every respect.

MONUMENT No. 23 — HIGHWAY STONE 1.

Is a highway monument standing at the south end of boundary line road. It is on line between the property of A. Haskins and J. McIntosh. This monument was found to be in good condition in every respect.

MONUMENT No. 24 — MILESTONE 9.

Is a highway monument standing on the east edge of boundary line road, on level ground, at northeasterly edge of a low bluff, and 150 feet south of Black brook, a branch of French creek. It is on line between the property of Douglas and Greenman. This monument was found to be in good condition in every respect.

MONUMENT No. 25 — HIGHWAY STONE 1.

Is a highway monument standing at the west side of boundary line road, at its junction with road, running southeasterly to Findlay's lake. It is on line between the property of Douglass and Greenman. This monument has heaved 4 inches, otherwise it was found to be in good condition.

MONUMENT No. 26 — MILESTONE 8.

Is a highway monument standing in cultivated ground, 645.3 feet south of the northeast corner of the township of Greenfield, Erie county, Pennsylvania, on the west side of boundary line road, and 950.7 feet north of monument No. 25. It is on line between the property of Greenman and Douglass. This monument was found to be in good condition in every respect.

MONUMENT No. 27 — TOWN STONE.

Is a highway monument standing on the west side of a boundary line road, 15 feet east of the end of a Pennsylvania farm fence, 15 feet south of where a brook crosses the line, and 3 feet northeast of small boulder. It is on line between the property of Douglass and Greenman. This marks the corner of the townships of Greenfield and Northeast, Erie county, Pennsylvania. This monument has its top flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 28 — HIGHWAY STONE 1.

Is a highway monument standing on the west side of boundary line road, opposite Mina schoolhouse, No. 13, and at junction with road running to Grahamville. It is on line between the property of Chasely and Greenman. This monument has its top 2 inches above the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 29 — HIGHWAY STONE 2.

Is a highway monument standing on the west side of boundary line road, at its junction with road running southeasterly to Findlay's lake. It is on line between the property of Chasely and Greenman. This monument was found to be in good condition in every respect.

MONUMENT No. 30 — MILESTONE 7.

Is a highway monument standing on the west side of boundary line road, upon a southwesterly slope, on cultivated land, opposite the center of a private road leading east to the residence of Charles Stetson, and 1,858 feet north of monument No. 29. It is on the

property of the Stetson estate. This monument was found to be in good condition in every respect.

MONUMENT No. 31—HIGHWAY STONE 1.

Is a highway monument standing on the north side of boundary line road, at its junction with road leading westerly to the borough of Northeast, and about 600 feet south of monument No. 32. It is on line between the property of J. Cardot and J. C. Pitt. This monument was found to have its east edge and southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 32—MILESTONE 6.

Is a highway monument standing on level cleared land, on west side of boundary line road, 431.7 feet south of monument No. 33. It is on line between the property of Chance Cordon and C. Sigby. This monument was found to be in good condition in every respect.

MONUMENT No. 33—HIGHWAY STONE 1.

Is a highway monument standing at north end of boundary line road, at its junction with road, running westerly to the borough of Northeast. It is on line between the property of Chance Cordon and C. Sigby. This monument was found to be in good condition in every respect.

MONUMENT No. 34—MILESTONE 5.

Is a small monument standing in level cultivated land, under worm fence, and about 1,200 feet south of monument No. 35. It is on line between the property of E. Stone and J. Burden. This monument was found to be in good condition in every respect.

MONUMENT No. 35—HIGHWAY STONE.

Is a highway monument standing on north side of road, leading from Northeast to Sherman. It is on line between the property of J. Tripp and E. Stone. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 36 — MILESTONE 4.

Is a small monument standing in cleared land, on a gentle northwesterly slope, east side of line fence, and in a narrow opening between two pieces of woods on the New York side of the line. It is on line between the property of E. Stone and the Tripp estate. This monument was found to be in good condition in every respect.

MONUMENT No. 37 — GULF STONE.

Is a small monument standing in thick open woods, on left bank of steep gorge, about 30 feet south from edge of bluff, and 1,938 feet north of monument No. 36. It is on the property of J. Simonds. This monument was found to be in good condition in every respect.

MONUMENT No. 38 — HIGHWAY STONE.

Is a highway monument standing on the north side of a highway leading from Ripley to Northeast. It is on the property of J. Simonds. This monument was found to be in good condition in every respect.

MONUMENT No. 39 — MILESTONE 3.

Is a small monument standing in open cultivated land, on level wet ground, in bottom of broad shallow ravine, in worm fence, 100 feet south of Pennsylvania east and west fence, and 2,300 feet north of monument No. 38. It is on the property of J. Simonds. This monument was found to be in good condition in every respect.

MONUMENT No. 40 — GULF STONE 1.

Is a small monument standing on level ground, in thick young woods, about 40 feet south of the south bank of canyon of Twenty-mile creek and on the east side of line fence. It is on the property of J. Simonds. This monument was found to be in good condition in every respect.

MONUMENT No. 41 — GULF STONE 2.

Is a small monument standing in thick woods, on level ground, in a small depression, 40 feet west of a low bluff, and about 30 feet north of the north bank of canyon of Twenty-mile creek. This monument was found to be in good condition in every respect.

MONUMENT No. 42—HIGHWAY STONE 1, SECTION STONE.

Is a highway monument standing on the south side of a road, which, in the vicinity of this point, is but little used. It marks the corners of sections 89 and 8. This monument was found to be in good condition in every respect.

MONUMENT No. 43 — RAILROAD STONE 1.

Is a small monument standing between the tracks of the New York, Chicago and St. Louis railroad (Nickel Plate). This monument has its east side badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 44 — MILESTONE 2.

Is a small monument standing in a vineyard on level ground, about 150 feet west of fence running nearly north and south, and 443.8 feet south of monument No. 45. This monument was found to be in good condition in every respect.

MONUMENT No. 45 — RAILROAD STONE 1.

Is a small monument standing on an embankment of the Lake Shore and Michigan Southern railroad, between the tracks. It has its top buried about one foot below the surface of the roadbed, otherwise it was found to be in good condition.

MONUMENT No. 46 — HIGHWAY STONE 1.

Is a highway monument standing at the south end of boundary line road, under the northwest corner of the porch of the store of H. W. Palmer and Son, which is on the south side of the main road, leading to Northeast. It is on the property of the H. W. Palmer estate. This monument has been destroyed by fire.

MONUMENT No. 47 — HIGHWAY STONE 2.

Is a highway monument standing at north end of boundary line road, on its east side where it turns westerly into Pennsylvania. It is on line between the property of Perry Wolf and William Wolf. This monument was found to be in good condition in every respect.

MONUMENT No. 48 — MILESTONE 1.

Is a small monument standing in partially cleared marshy land, at the east edge of brush fence, 849.8 feet north of monument No. 47, and about 25 feet north of small maple, branching near the bottom, standing about 10 feet west of line in the thicket. It is on the property of Garret Felton. This monument has heaved 3 inches, otherwise it was found to be in good condition.

MONUMENT No. 49 — HIGHWAY STONE 1.

Is a highway monument standing on north side of highway leading along the shore of Lake Erie. It is on line between the property of Garret Felton and J. Conley. This monument was found to be in good condition in every respect.

MONUMENT No. 50 — INITIAL MONUMENT.

Is a large monument of Quincy granite, cut in the form of a flat obelisk, with its broad faces set in the direction of the line. It stands 4 feet out of the ground, with a cross section 2 feet by two-thirds of a foot. It is lettered on the east face as follows:

"Meridian of the west end of Lake Ontario, State of New York; 18 miles 52.5 chains from the north boundary of Pennsylvania. August 23rd, 1790."

The west face is marked as follows:

"Territory annexed to the State of Pennsylvania, north latitude 42 degrees 16 minutes 13 seconds; variation 25 seconds west."

The north side is marked as follows:

"1869. Latitude of this stone, 42 degrees, 15 minutes, 57.9 seconds; longitude of this stone, 79 degrees, 45 minutes, 54.4 seconds; variation, 2 degrees 35 minutes west."

The south side is marked as follows:

"1869. Erected by the States of New York and Pennsylvania, 440 feet south of monument now dilapidated, on which were the inscriptions on the east and west faces of this monument."

This monument was set in 1869, 440 feet south of the original monument in 1790. It was readjusted in alignment in 1885. It stands in cultivated land, level ground, 150 feet north of

monument No. 49. It is on line between the property of J. Connor and Garret Felton. This monument was found to be in good condition in every respect.

MONUMENT No. 51 — BLUFF STONE.

Is a small monument standing upon the bluff overlooking Lake Erie, 40 feet south of site of the original initial monument of 1790, about 40 feet south of the edge of the bluff and 550 feet north of monument No. 49. It is on line between the property of Garret Felton and J. Connor. This monument was found to be in good condition in every respect.

NEW YORK AND NEW JERSEY.

Report on the Examination of Monuments Marking the Boundary Between the States of New York and New Jersey.

ALBANY, *December* 30, 1896.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor, Albany, N. Y.:*

Sir.— I have the honor to submit this report on the examination of the monuments marking the boundary line between the States of New York and New Jersey, undertaken in accordance with your instructions.

The locating and establishing of the different parts of this line were done under such different circumstances, and the monuments themselves are of so varied a nature that it is deemed advisable, for the purposes of this report, to subdivide the line into four parts, as follows:

Subdivision one. In Raritan bay between Romer Stone beacon and the Permanent Monument.

Subdivision two. In the Arthur kill or Staten Island sound, in the Kill von Kull and in New York bay.

Subdivision three. In the Hudson river, to the northeast boundary line of New Jersey.

Subdivision four. On the northeast boundary line of New Jersey, between the Hudson river and the Delaware river.

SUBDIVISION ONE.

The value of the lands under water in Raritan bay, for the propagation and cultivation of oysters, became apparent early in the century. This long, shallow land-locked bay, with its hard, sandy bottom, subject to the action of the ocean tides and fed by numerous streams of fresh water, with their vegetable matter, possesses all the qualities necessary for the highest and most successful development of shell-fish culture.

Oysters were found here in great abundance by the early settlers, and for a time were amply sufficient to supply the wants of the then scanty population. As the population increased, the demand for oysters became greater, and soon it became necessary, if the future beds were to be saved from total depletion, to adopt some artificial means of cultivation. Oysters were first planted in 1810. Up to this time the whole bay had been used in common by the residents of the adjoining shores, no attempt ever having been made to locate the boundary line, but now, owing to the increased value of the land, due to the growing importance of the industry, disputes arose as to where the line was located. These disputes, which oftentimes resulted in bloodshed, became so frequent that it became imperative on both States to define this boundary line.

Accordingly, in 1834, an agreement was entered into and ratified by the States of New York and New Jersey that the boundary line in Raritan bay should be "the middle of the bay to the sea." This location, though somewhat indefinite, answered for the time being.

The rapidly increasing number of planters, and a corresponding demand for oyster lands, soon led to the occupation of every desirable and available piece of ground.

It was then that the vagueness of the line as given by the agreement of 1834 became apparent; and the disputes and contentions which this agreement was intended to end arose with more frequency than before.

By the agreement of 1834 the line was said to be "the middle of the bay to the sea." If the adjoining shore lines were straight the determination of the boundary line would be a simple problem,

but as the shores consisted of alternate coves and headlands, it beame a matter of some difficulty to agree upon a just and central boundary. Did the agreement of 1834 mean that the area of the coves should be taken into consideration in determining the "middle of the bay to the sea," or was it intended that this should be neglected and lines drawn from headland to headland, and the area of the bay included between these lines be computed and equally divided.

As the persons directly interested could reach no agreement on this question, petitions were sent to the Governors of the States of New York and New Jersey asking that a joint commission be appointed to determine the location of the line. Accordingly, by chapter 69, Laws of 1887, the Governor of New York appointed three commissioners who were "to have full power on the part of the State of New York to meet the commissioners appointed or to be appointed by the State of New Jersey, and with them locate and mark out by proper monuments and buoys the true boundary line between the two States in lands under water in Raritan bay.

This Commission, after many meetings and much discussion, adopted the following report as to the location of this part of the line:

First.—From the "Great Beds lighthouse" in Raritan bay north 20° 16′ west true to a point in the middle of the waters of Arthur Kill or Staten Island sound, equidistant between the southwesterly corner of the dwelling house of David C. Butler at Ward's point on Staten Island, in the State of New York, and the southeasterly corner of the brick building on the lands of Cortland L. Parker, at the intersection of the westerly line of Water street with the northerly line of Lewis street in Perth Amboy, in the State of New Jersey.

Second.—From "Great Beds lighthouse" south 64° 21′ east true in line with the center of Waac Kaack or Wilson's beacon in Monmouth county, New Jersey, to a point at the intersection of said line with a line connecting "Morgan No. 2" Triangulation Point, U. S. Coast and Geodetic Survey, in Middlesex county, New

Jersey, with the granite and iron beacon known as "Romer Stone Beacon," situated on "Dry Romer Shoal," and thence on a line bearing north 77° 9′ east true connecting "Morgan No. 2." with said Romer stone beacon (the line passing through said beacon and continuing in the same direction), to a point at the intersection with a line drawn between the "Hook beacon" on Sandy Hook, New Jersey, and the Triangulation Point of the U. S. Coast and Geodetic Survey known as the Oriental Hotel, on Coney Island, New York, then southeasterly at right angles to the last mentioned line to the main sea.

Third.—The monumental marks by which said boundary line shall be hereafter known and recognized are herby declared to be as follows:

1. The Great Beds lighthouse.

2. A permanent monument marked "State Boundary Line, New York and New Jersey," and to be placed at the intersection of the line drawn from "Great Beds lighthouse" to Waack Kaack or Wilson's beacon, Monmouth county, New Jersey, and the line drawn from Morgan No. 2, Triangulation Point, U. S. Coast and Geodetic Survey in Middlesex county, New Jersey, to Romer stone beacon.

3. Eight buoys or spindles, to be marked like the Permanent Monument above mentioned, and to be placed at suitable intervening points along the line from the Permanent Monument to the Romer Stone beacon.

4. The Romer Stone beacon.

Fourth.—The maps accompanying and filed with this agreement showing the location of the above described boundary line between the State of New York and the State of New Jersey in Raritan bay to the main sea, and of the monumental marks by which it is marked and to be marked, duly authenticated and attested by the signatures of the said commissioners and placed on file in the office of the Secretary of State of the respective States, shall constitute the permanent and authentic record of said boundary line and are hereby adopted by the parties hereto and made part of this agreement.

By carrying into effect articles of this agreement the line was plainly and definitely marked, and an end put to the wrangling of nearly a century. This satisfactory condition of affairs was not of long duration, for in the spring of 1890 the buoys which had been placed on line between the Romer Stone beacon and the Permanent Monument, were carried away, and since that time nothing has existed to show the location of the line between these points, a distance of twelve miles, and it again becomes necessary to adopt some means to indicate where this line is.

Experience has proven that no buoys, no matter how securely anchored, will retain their position in Raritan bay, so that it would be useless to employ them again; to erect any monument of a permanent nature is objectionable, not only on account of its cost, but also because it would prove an obstruction to navigation.

The only plan which seems practicable is to erect a tower or some permanent beacon over the point known as "Morgan No. 2," and with this and the Permanent Monument as range points, it will be a simple matter for any one to place himself on line.

All the other determining points on this part of the line were found to be in good condition.

SUBDIVISION 2.

The jurisdiction of the commissioners appointed to locate and mark out the line in Raritan bay was extended by chapter 159, Laws of 1888, and chapter 212, Laws of 1889, so as to include the Arthur Kill, Kill von Kull, New York bay and the Hudson river. They reported as to the location of this part of the line as follows:

First.—Starting from a point (at the conclusion of the boundary line in Raritan bay) and marked for the purposes of this agreement A. This point is equidistant between the southeasterly corner of the dwellinghouse of David C. Butler at Ward's Point on Staten Island in the State of New York and the southerly corner of the brick building on the lands of Cortland L. Parker at the intersection of the westerly line of Water street with the northerly line of Lewis street in Perth Amboy, in the State of New York.

The line runs thence in a succession of straight lines through the Arthur Kill, Kill von Kull, New York bay and the Hudson river, to

a point marked JJ for the purposes of this agreement. This point JJ is at the extreme northern limit of the boundary line in lands under water, and from this point the line runs westerly to Station Rock. The absolute geographical location of the points at the place of beginning and the place of conclusion are as follows:

Point A (Place of beginning).

Latitude. Seconds in Metre. Longitude. Seconds in Metre.

(Latitude and longitude not given. Description sufficient.)

Point JJ (Place of conclusion).

Latitude.	Sec. in Metre.	Longitude.	Sec. in Metre.
40° 59′ 49″ 74 N.	1,534.38	74° 53′ 38″ 57 W.	901.46

The point at which changes of direction occur in the boundary line from the place of beginning to the place of conclusion are for the purposes of this agreement lettered or numbered and their determination and absolute geographical positions are as follows:

	Latitude.				Sec. in metre.	Longitude.				Sec. in metre.
	Deg.	Min.	Sec.			Deg.	Min.	Sec.		
B	40	30	31	N.	956.2	74	15	30.74	W.	723.9
C	40	30	56	N.	1727.33	74	15	16.22	W.	382.
D	40	31	15 07	N.	464.8	74	14	47 15	W.	1109.9
E	40	32	31.9	N.	984.	74	15	02.5	W.	58.8
F	40	32	57.38	N	1769.9	74	14	52.42	W.	1283.9
G	40	33	32.68	N.	1008.	74	13	54.57	W.	1284.
H	40	33	25.03	N.	172.	74	13	06.29	W.	148.
I	40	33	37.54	N.	1157.9	74	12	53.95	W.	1269 4
J	40	34	25.03	N.	772.	74	12	38.	W.	893.7
K	40	35	16.12	N.	498.	74	12	27.55	W.	647.9
L	40	35	51.87	N.	1599.9	74	12	00.	W.	0.
No. 1 ..	40	36	01.	N.	30.8	74	12	00.	W.	0.
No. 2 ..	40	36	21.45	N.	661.6	74	12	18.88	W.	443.9
No. 3 ..	40	36	51.02	N.	1573.7	74	12	15.48	W.	363.9
No. 4 ..	40	37	00.	N.	0.	74	12	10.21	W.	240.
O	40	37	27.36	N.	844.1	74	12	15.61	W.	366.9
P	40	37	43.24	N.	1333.7	74	12	09.69	W.	227.9
R	40	37	53.36	N.	1645.9	74	12	10.12	W.	238.
S	40	38	04.86	N.	149.9	74	11	54.87	W.	1289.3
Position: Center of Baltimore and Ohio bridge pier.										
[illegible]	40	38	15.31	N.	472.8	74	11	47.97	W.	1125.9
A^1	40	38	30.92	N.	953.7	74	11	30.63	W.	719.8
B^1	40	38	45.38	N.	1399.8	74	11	09.79	W.	229.9
C^1	40	38	47.13	N.	1453.7	74	10	55.42	W.	1301.8
D^1	40	38	30.79	N.	949 7	74	08	36 68	W.	861.9
E^1	40	38	36.89	N.	1137.9	74	08	00.	W	0.0
F^1	40	38	31.37	N.	967.6	74	07	35 15	W.	825.8
G^1	40	38	52.66	N.	1624.3	74	06	36.94	W.	867.9
H^1	40	38	52.66	N.	1624.3	74	05	37 88	W.	889.8
I^1	40	39	05.05	N.	155.77	74	05	14.64	W.	343.09
J^1	40	39	04.94	N.	152.38	74	03	22 25	W.	522.65
AA ...	40	42	00.	N.	0.0	74	01	36.50	W.	857.0
BB	40	43	04.68	N.	144.36	74	01	26.59	W.	624.07
CC	40	45	26 82	N	827.3	74	00	52.	W.	1219 66
DD ...	40	49	35.55	N.	1096.61	73	57	50.38	W.	1180 6
EE	40	51	03.62	N.	111.67	73	57	11.69	W.	273.78
FF	40	53	19.05	N.	587.64	73	55	48.77	W.	1141.7
GG ...	40	55	40 3	N.	1243 13	73	54	52.82	W.	1235.61
HH ...	40	56	48.22	N.	1487.48	73	54	33 35	W.	780 06
II	40	58	54.39	N.	1677.82	73	53	47.63	W.	1113.58
JJ	40	59	49.74	N.	1534.38	73	53	38.57	W.	901 46

Second. The monumental marks by which said boundary line shall hereafter be known and recognized have been carefully described, their absolute geographical position given and this description and location will be filed in the office of the Secretary of State of New York and Secretary of State of New Jersey.

Third. The map accompanying and filed with this agreement, showing the location of the above mentioned boundary line between the State of New York and the State of New Jersey in lands under in the Arthur Kill, Kill von Kull, New York bay and the Hudson river and of the monumental marks by which such line may be distinguished and known, duly authenticated and attested by the signatures of the aforesaid commissioners and placed on file in the office of the Secretary of State of the respective States shall constitute the permanent and authenticated record of said boundary line and are hereby adopted by the parties hereto and made parts of this agreement.

The actual location of the points where the line changes direction is determined by range monuments and permanent objects such as chimneys, church spires and flag staffs placed on the adjoining shores. The range monuments are of granite 8 inches by 8 inches in cross sections, and project 6 inches out of the ground; the letters N. Y., N. J., are cut on the northerly face and B. M. 1889 on the southerly face. Two one-quarter inch grooves, one in the direction in which the monument ranges and the other at right angles thereto are cut in the top of each monument.

No suggestion for the betterment of this part of the line can be offered as all the monuments, with the exception of a few which were slightly chipped, were found to be in perfect condition.

The location of these monuments is as follows:

MONUMENT No. 1.

For range through to Great Beds lighthouse, dp 680.64, dm 1,081.61. This monument is at Perth Amboy, N. J. It is in the rear of Abr. Slaight's blacksmith shop. His shop is on the east side of the street, running along kill and adjoins C. M. Whittaker's marine railway. This monument has its top flush with

the surface of the ground; otherwise it was found to be in good condition.

MONUMENT No. 2.

For range through B to low brick chimney, Perth Amboy, dp 693.23, dm 431.03. This monument is in the Cliff Park grove, at Tottenville, Staten Island, on the property of C. C. Ellis, at present leased by J. H. Starin. It is on the west slope of steep bank, almost directly opposite the ferry dock in Perth Amboy, fifty-two yards north of line fence between the properties of Biddle and Ellis, and thirty-two yards from high water mark. The low chimney in Perth Amboy, to which this monument ranges, is one connected with the Rosseter chemical works, and is near the northwest corner of Water and Commerce streets, it is about 66 feet high. This monument has its southwest corner slightly chipped; otherwise it was found to be in good condition.

MONUMENTS Nos. 3 and 4.

For range through B, dp 1,077, dm 300, for more westerly monument. These monuments are on the property of W. H. B. Totten, near the west slope of bank. Most westerly monument is just about opposite the opening of a street in Perth Amboy, N. J., running east and west. The street is the first one south of the terra cotta works. This monument is thirty-five yards east of line fence between Robinson's and Totten's, and is 136.94 feet southwesterly on this range from the other monument. It is on line between property of Robinson and Totten. No. 4 has its northeast corner chipped, and No. 3 has its edges slightly chipped, otherwise they were found to be in good condition.

MONUMENT No. 5.

For range through C to Lehigh Valley railroad shop's chimney, dp 1,363.55, dm 198.46. This monument is on the property of David Van Name, just about opposite Perth Amboy terra cotta works. It is near a large willow tree in the rear of the house occupied by Reuben Daggatt, 64.28 feet to the northwest corner of the house. The chimney in this range is attached to car shops of the works of the Lehigh Valley railroad, just on the southern limits

of Perth Amboy. This monument was found to be in good condition.

MONUMENT No. 6.

For range through D to Kreisher's chimney, dp 1,709.67, dm 1,311.68. This monument is on the property of John M. Sleight in Staten Island. This monument is 6 feet from high water mark, 17 feet from northeast corner of line fence, between J. M. Sleight and house of Joseph A. Sleight and four paces north of small ditch. This monument has its top flush with the surface of the ground; otherwise it was found to be in good condition.

MONUMENT No. 7.

For range through C to fire brick works chimney, dp 1,808.45, dm 1,050.66. This monument is on the property of Alfred H. Sprague, in Staten Island. It is 48.71 feet from the line fence between the property of Sprague and Henry Christopher and 15 feet along side line fence to the line of Fisher street. This monument was found to be in good condition.

MONUMENT No. 8.

For range through D to Boynton chimney, dp 75.88, dm 948.83. This monument is on the property of Captain Oliver Weir, in Staten Island. It is in the dooryard of his house, under a small tree 24.6 feet from line fence between the property of Weir and Rudolph Craft, and 51.2 from the northeast corner of Weir's house. This monument was found to be in good condition.

MONUMENT No. 9.

For range through E to Boynton's chimney and F to monument 12, dp 1,146.3, dm 1,027.1. This monument is on the property of R. H. Boyde, in Staten Island, opposite the Seawarren hotel, New Jersey. This monument is about 210 feet northwest of the most northerly of two houses, and is 1 foot south of line fence separating Boyde's property from J. Stony. It is on northwest slope of hill falling gently to Arthur Kill, 275 feet distant. This monument was found to be in good condition.

MONUMENT No. 10.

For range through E to Kreisher's chimney, dp 1,568.5, dm 489.9. This monument is 59 feet west of road running along water front from Seawarren hotel to Central Railroad of New Jersey depot. It is on the property of John Taylor Johnson, about 800 feet from northwest corner of hotel and 58 feet west of west gutter of roadway, and 28.21 feet from southeast corner of Cuppia's residence. This monument was found to be in good condition.

MONUMENT No. 11.

For range through F to paper mill chimney, dp 1,664.61, dm 495.9. This monument for range through F to paper mill chimney is on the property of John Taylor Johnson, of Seawarren, N. J., on the west side of the road from Seawarren hotel, along water front to station of Central Railroad of New Jersey. It is about 30 feet from row of trees in edge of sidewalk nearest roadway, on west side, and on west side of driveway leading to residence of Mr. Solace. There are witness stones on the range line 3 feet eastward and westward of the monument. This monument was found to be in good condition.

MONUMENT No. 12.

For range through F to monument No. 9, dp 1,195.05, dm 245. This monument is on the southwest side of the road leading from Seawarren northward, and running along edge of meadow. The monument is in line with row of maple trees that line the edge of the road. It is about 140 feet along range line to the edge of meadow, 7.8 feet to tree on south and 16.7 feet to tree on north. It is on the property of John Taylor Johnson. This monument was found to be in good condition.

MONUMENT No. 13.

For range through G to Smoky Point monument No. 15, dp 1,672.3, dm 371. This monument is on the south slope of bank, 12 feet from the edge of salt meadow and 400 yards easterly from main road to Seawarren. It is on the property of Port Reading railroad. This monument was found to be in good condition.

MONUMENT No. 14.

For range through G to paper mill chimney, dp 6,617, dm 1,050.88. This monument is situated in an open field next to a meadow, near the fence, about 200 yards east of the residence of Henry A. Turner, and 83 yards west of large hickory tree. It is on the property of Port Reading Land Company. This monument has its four corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 15.

For range through G to monument No. 13, New Jersey, dp 610.45, dm 985.77. This range also passes through the United States Coast and Geodetic Survey station, Smoky Point. This monument is on the edge of upland, 7 feet higher than the meadow. It is 407 feet along the range from the water to the monument, 39 feet from edge of the meadow and 238 feet to the northeast corner of the residence of John Dissosway. It is on the property of John Dissosway. This monument was found to be in good condition.

MONUMENT No. 15-a.

For range through G to monument No. 13, dp 450.53, dm 865.75. This range also passes through monument No. 15 and the United States Coast and Geodetic station, Smoky Point. It is 200 feet southeasterly on range from monument No. 15. This monument was set December 15, 1893, to preserve the range between Nos. 13 and 15. It is 6 x 6 inches in cross-section, and projects out of the ground about 6 inches. It is on the property of John Dissosway. This monument was found to be in good condition.

MONUMENT No. 16.

For range through H to Melvin chimney, dp 497.02, dm 290.68. This monument is at Rossville, S. I., on the estate of Caleb Lyon. It is 6 feet south of road, 25 feet west of line fence and 85 yards eastward from the northwest corner of the residence of Lyon. This monument was found to be in good condition.

MONUMENT No. 17.

For range through I to Melvin chimney, dp 448.21, dm 203.05. This monument is at Rossville, S. I. It is on an easterly slope, 3 feet from fence dividing the dooryard of Miss Mary Cole from pasture, 85 feet along fence to public road and 146 feet along public road eastward to small creek or gut. It is on the property of Miss Mary Cole. This monument has its northwest corner and south edge slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 18.

For range through H to monument No. 20, dp 505.84, dm 98.04. This monument is at Rossville, S. I., just inside fence on south side of public road, 23 feet from line fence between property of Mrs. Seguine and John Dissosway, and 70 feet from street intersecting public road. This monument is on the property of Mrs. H. O. Seguine. This monument was found to be in good condition.

MONUMENT No. 19.

For range through I to monument No. 20, dp 831.63, dm 909.42. This monument is on Staten Island, on north slope of hill, 7 feet from edge of meadows, 46 yards from public road and 130 yards from line fence between the property of Thomas P. Hardy and Harmon Decker. It is on the property of Harmon Decker. This monument was found to be in good condition.

MONUMENT No. 20.

For range through H to monument No. 18, through to monument No. 19, dp 1,554.24, dm 295.24. This monument is at Sylvan Beach, N. J., 5 feet south of line fence between the property of Milton Arrowsmith and Thomas Sawyer, and 100 yards northeasterly to the corner of fence around Arrowsmith's barnyard. It is on the property of Thomas Sawyer. This monument was found to be in good condition.

MONUMENT No. 21.

Ranges through J to Melvin's chimney, dp 235.16, dm 1,291.71. This monument is at Sylvan Beach, N. J., in thick bushes

300 yards north of the residence of Thomas Sawyer, 38 paces north of the north fence of the Lucol Oil Co., on the edge of uplands, and 35 yards south of where the upland turns to the west. It is on the property of Thomas Sawyer. This monument was found to be in good condition.

MONUMENTS Nos. 22 and 23.

For range through J (23) dp 1,098.52, dm 1,264.83 (22) dp 998.10, dm 1,150.66. These monuments are in New Jersey, on the uplands. The more easterly monument is about 35 feet northwest of a large willow tree about 250 feet north of Liebig's factory, 20 feet from the meadow, and about 80 feet south of branch railroad. The more westerly monument is 140 yards east of the public road on north end of uplands, where upland turns to the west, 15 paces southeast of a 10-inch oak; 10 feet from the meadow, and 498.73 feet west from monument No. 22. Both these monuments are on the property of Carl Rectnagle. They were found to be in good condition.

MONUMENT No. 24.

For range through K to monument No. 29, dp 1,811.1, dm 1,052. This monument is near Star Landing, N. J., 20 feet north of the meadow and just west of a foot-path leading to the fertilizer factory, 250 feet north of the north side of the road leading to Carteret station. A small house at the end of a cable crossing stands on the salt meadow east by south of the monument. It is on the property of Charles Lot. This monument was found to be in good condition.

MONUMENT No. 25.

For range through L and No. 1 to monument No. 33, dp 550.66, dm 0. This monument is at Linoleumville, S. I., near the edge of meadow about 200 yards south of public road, passing through Linoleumville down to pier, about 50 feet west of large chestnut tree, and 100 feet south of fence that extends from the woods into the meadows. It is on the property of Linoleum Co. This monument has its four corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 26.

For range through K to Melvin chimney, dp 968.6, dm 598.85. This monument is in New Jersey, 55 yards at right angles, north of branch railroad running from Cartaret to Clark's factory on upland. It is on the property of George F. Gantz. This monument was not found.

MONUMENTS Nos. 27, 28, 29.

Twenty-seven to 29 range, through 1 and 2 (27), dp 1,354.31, dm 1,039.78; (29), dp 1,611.7, dm 1,220.9, 28 ranges through L to monument 30; (28), dp 1,352.6, dm 1,090.5. These monuments are all on Staten Island, just south of Chelsea. The most northerly one is upon a meadow belonging to Mr. Meyer. It is 200 feet northeast of a creek and 50 feet east of kill. The other two monuments are on the upland on property in charge of Marshall Cameron. The more westerly one is 150 feet north of public road, and the other is 250 feet north of road. Monument 29 is 20 feet east of the United States Coast Survey signal ("Meyers"); all three monuments were found to be in good condition.

MONUMENTS Nos. 30 and 31.

For range through 2 and L (30), dp 431.1, dm 886.95; (31), dp 498.27, dm 762.2. These monuments are both on Tremley neck in New Jersey, just upon the upland; distance between the monuments is 355.5 feet. Monument 30 is about 165 yards from hotel and 60 feet north from angle in wire fence. These monuments are on the property of John D. Wynants, and are in good condition.

MONUMENT No. 32.

For range through 3 to monument 34 in Staten Island, dp 775.8, dm 1,115.5. This monument is on Tremley Neck, N. J., on the upland, 5 feet south of meadow land on north edge of woods. The meadow line makes a sharp turn to the west about 75 feet northwest of the monument; a large oak tree is 60 feet southwest of the monument. It is on the property of John D. Wynants. This monument was found to be in good condition.

MONUMENT No. 33.

For range through 4 to monument 39 and through 3 to Standard Chemical chimney, dp 1,345.78, dm . .00. This monument is on Prall's Island, near the north end, 80 yards west of the inside channel. This monument was found to be in good condition.

MONUMENT No. 34.

For range through 3 to monument 32, and through 4 to Standard Chemical chimney, dp 262.2, dm 1,266.62. This monument is on Staten Island, on property of Joseph Ball, on meadow just north of Prall's Island, and 925 feet from kill just at head of gut, which flows westerly into kill. This monument was found to be in good condition.

MONUMENTS Nos. 35 and 36.

Thirty-five ranges through P to monument 38, and through R to Standard Chemical chimney, dp 1,805.9, dm 303.9; 36 ranges through S to the more easterly Bouker fertilizer factory chimney, dp 805.9, dm 338.9. These monuments are on the upland about 500 feet westerly from the house occupied by A. M. Decker and on the north edge of a grove of young oaks. The monument the more westerly is 75 feet east of where the upland makes a sharp turn to the south and the other monument is 108 feet east directly of the first one, and along north edge of woods. These monuments are on the property of the J. S. Sutter estate, north of Bloomfield. These monuments were found to be in good condition.

MONUMENT No. 37.

Dp 844.1, dm 366.9, on Buckwheat Island, near the north end and marks boundary station zero. This monument was found to be in good condition.

MONUMENTS Nos. 38 and 39.

Thirty-eight ranges through P to No. 35; 39 ranges through 4 to No. 33; 38, dp 1,809.75, dm 2.51; 39, dp 271.24, dm 1,248.65.

These monuments are on the New Jersey shore, on uplands some distance back from kill. No. 39 is just at the edge of the meadow and upland about 450 yards west of the Central Railroad of New Jersey and 750 yards southerly along an avenue which starts from the forty-second bent (counting from the west) of the Baltimore and Ohio railroad trestle at Bay Way, and 40 yards east of said avenue. This avenue has been opened, but not used. No. 38 is 1,200 feet south of No. 39, 40 feet from edge of meadow on gentle slope of upland. These monuments are on the property of D. Bounet, real estate agent, and were found to be in good condition.

MONUMENT No. 40.

For range through R to Standard Chemical chimney, dp 132.07, dm 187.76, just below the Baltimore and Ohio railroad bridge in New Jersey, on upland 30 yards north of creek. This monument is on property of Fire Proof Building Company, and was found to be in good condition.

MONUMENT No. 41.

For range through S to Standard Chemical chimney, dp 355.35, dm 929.68, on Staten Island, on meadow 19 yards at right angles from large ditch, running parallel with the Baltimore and Ohio trestle on south side. The range line from monument through S to Standard Chemical chimney produce backward intersects the trestle in the twenty-ninth bent, between the two uprights, counting from the most easterly foundation pier. This monument was found to be in good condition.

MONUMENT No. 42.

For range through B to Glue Factory chimney H to Oil Cloth Company's chimney, dp 774.86, dm 582.08, on Staten Island, in bend of gut flowing into ditch north of and parallel to Baltimore and Ohio trestle and 300 yards from Baltimore and Ohio trestle. This monument is on the property of William Dooly. This monument was found to be in good condition.

MONUMENTS Nos. 43, 44, 45.

Forty-three ranges through C to the more easterly of the two tall chimneys at Singer's factory, dp 1,248.8, dm 28.91. Forty-four ranges through B to Presbyterian church spire, dp 1,275.19, dm 1,394.21. Forty-five ranges through C to glue factory chimney, dp 1,140.86, dm 1,224.08; range north 20° west of workshop of Dooly Railway; also north 66° east to opening in dyke. All three monuments are in the immediate vicinity of Dooly's Marine Railway, and are all on Staten Island, on meadow of William Dooly. No. 43 is about 50 feet westerly of the third telephone pole from the kill and about 150 feet south of small shanty standing on bank of kill. No. 45 is south 43° west about 600 feet from F. M. Henderlita's house. These monuments were found to be in good condition.

MONUMENT No. 46.

For range through B to Bergen Point light, dp 814.53, dm 388.4, at Port Richmond, S. I., in rear of William Ross' lot, near kill. This monument was found to be in good condition.

MONUMENT No. 47.

For range through E to Bergen point spire, dp 342.37, dm 303.16. This monument is at Port Richmond, Staten Island, rear of Abram Gibson's dooryard, 40 feet from kill, 3 feet from the fence between property of Gibson and Stephen Squires, and 75 feet from line fence between property of Gibson and Ebhard Faber. This monument was found to be in good condition.

MONUMENTS Nos. 48 AND 49.

No. 48 ranges through D and produced in the opposite direction it passes through the center of the Agricultural Works chimney, dp 1,292.65, dm 795.85. No. 49 ranges through E and F to monument 51. These monuments are at Bergen Point, N. J. No. 48 is near edge of meadows, 20 feet from kill; 50 feet westerly from track of hand railroad running from works down on pier, and north 17° east 180 feet from southeast corner of main building. No. 49 is 40 feet west of storage shed in little clump of trees, and 200 feet east of main building. They are on the property of Carr

and Hobson. No. 48 was found to be in good condition, and No. 49 was not found.

MONUMENT No. 50.

For range through F to northeast prong of a church in Port Richmond, dp 317.87, dm 920.26. This monument is at Bergen Point, N. J., on the south side of First street, fronting on kill near the foot of Lord avenue, 3 feet inside of fence and about 50 feet west of the east end of fence. It is on property of Rufus Story. This monument has its northeast corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 51.

For range through E and F to monument 49, dp 832.4, dm 398.95. This monument is at West New Brighton, S. I., in the rear of the property recently occupied by the Staten Island Star, a local newspaper; 4 feet from the stoop and 40 feet from Rapid Transit Railroad tracks. It is on the property of the Staten Island Star. This monument was found to be in good condition.

MONUMENT No. 52.

For range through G and H to monument 55. It is at Bergen Point, N. J., about 206 feet east of a street running from a new dock belonging to the city, about 60 feet from edge of meadow on a gentle easterly slope, and twelve feet from a large black walnut tree. It is on the Gunther estate. This monument was found to be in good condition.

MONUMENT No. 53.

For range through G to Oil company's chimneys, dp 1,318.59, dm 898.5. This monument is on Staten Island just west of Livingston Station on Rapid Transit road. It is 13 feet south of the center of the east wing of the electric light factory. It is on the property of Staten Island Electric Company. This monument was found to be in good condition.

MONUMENT No. 54.

For range through cross cut upon capstone of wall, 4′ 1″, dp 1,206.33, dm 7,709, mark on monument, dp 1,299.42, dm 1,483. This monument is on the property of Sailors' Snug

Harbor. It is 225 feet from Richmond terrace and 253 feet along range line from cross cut in capstone of fence, running parallel with and separating the property from Tyson street. The cross cut is the other range for H and I. This monument was found to be in good condition.

MONUMENT No. 55.

For range through G and H to monument 52, dp 1,624.31, dm 330.49. This monument is just inside curbing for sidewalk, one inch below surface. It is on north side of Richmond terrace, east of New Brighton (Rapid Transit) station, and about opposite the Windsor hotel and also about opposite east end of platform of station. This monument was not found.

MONUMENT No. 56.

For range through I to Crude Oil chimney, dp 1,571.89, dm 1,188.71. This monument is at St. George, Staten Island, on property of Baltimore and Ohio Railroad Company at west end of yard. It is 4 feet from foot of terrace, 60 feet from kill, 200 feet west of boathouse, 15 feet from switch south 57° west from Robbins Reef light, about 8 feet northeast of blazed telegraph pole. This monument has its north and south sides broken, otherwise it was found to be in good condition.

SUBDIVISION 3.

The boundary line in New York Bay and the Hudson River.

It was considered unnecessary to examine the range points which determine the line through these waters as they consist of crosses cut in rocks and prominent land marks. A detailed description of their location will be found in the report of the Riparian Commissioners of New Jersey for the year 1891.

SUBDIVISION 4.

The boundary line between the Hudson river and the Delaware river.

This part of the line was originally established and monumented by a commission in 1774. The lapse of a century has caused many

of the monuments to disappear, rendering the location of the line in places indefinite and uncertain. To remedy this condition a commission was appointed by chapter 340 of the Laws of 1880, "to ascertain and restore the boundary line between the States of New York and New Jersey, extending from the Hudson river on the east to the Delaware river on the west." A like commission baving been appointed by the State of New Jersey, operations were jointly commenced and the line as existing to-day established.

The monuments marking the line are of three classes—milestones, railroad monuments and highway monuments.

The milestones are 4 feet long and 6 inches square. The sides of the upper portion of the monument 6 inches in depth and top are smoothly dressed square, the remainder of the monument being left rough, the top has cut upon it, across the center, two quarter-inch grooves at right angles with each other and parallel with the sides. Upon the north side or face are cut the letters N. Y., upon the south side N. J. and upon the east side the number of miles from the eastern terminus.

The railroad monuments are similar to the milestones with the exception that the number of the mile is omitted.

The highway monuments are 4½ feet long, 12 inches wide and 6 inches thick. The sides of the upper end to a depth of 12 inches and the top are smoothly dressed. At right angles across the center of the top and parallel with the sides are cut two quarter-inch grooves. Upon one of the broad faces are cut the letters N. Y. and upon the other the letters N. J.

The condition of these monuments and the line in general, as disclosed by the examination is good; some of the monuments were chipped at the corners and sides and others leaned slightly from their truly vertical position, but in no case was the defect so great as to require resetting. The only suggestion that can be made for the betterment of the line is that a highway monument be placed on the road between monuments Nos. 52 and 53, and one on the road between Nos. 53 and 54; also, that a railroad stone be placed on the Poughkeepsie and Boston railroad where it crosses the line.

On the examination of the monuments on this part of the line I was accompanied by Mr. Spraul as the representative of the State of New Jersey; the rest of the line I examined alone.

I am indebted to the report of the joint commission of 1887 and 1888 for much of the information in relation to the establishing of the line in Raritan bay, Arthur Kill, and Kill von Kull.

Respectfully,

C. H. FLANIGAN.

Detailed Description of the Location of Monuments on the Boundary Line between the States of New York and New Jersey from the Hudson River to the Delaware River.

EASTERN TERMINAL MONUMENT.

The monument at the eastern terminus of the line is a large block of trap rock 7 feet 6 inches long, 3 feet 2 inches high and about 4 feet thick. It is located at the foot of the Palisades, about 6 inches above the storm tides of the Hudson river, 50 feet north of the south end of a slough and about 800 paces south of a small stream which falls over the Palisades. It is marked with a groove upon its perpendicular eastern face for its full height at a distance of 2 feet south from its northerly end, and is further marked with the words "Latitude 41 degrees north," and on the north side of the groove the words "New York," and on the south side thereof the words "New Jersey." It lies 313.21 feet south 18 degrees 44 minutes west from the United States Coast Survey station Duer, and, from the determinations of that survey, it is in latitude 40 degrees 59 minutes 48.17 seconds north, longitude 73 degrees 54 minutes 11 seconds west from Greenwich. The lettering on the rock is very indistinct and should be recut.

EASTERN WITNESS OR REFERENCE MONUMENT.

This monument is 488 feet from the terminal monument on the bank of the Hudson river and is 350 feet above tide level. It stands opposite a point on the Hudson River railroad about midway between Dobbs Ferry and Hastings, and the boundary line, if extended across the Hudson, would cross the railroad near the tall, old chimney south of Hastings. By clearing away bushes

in its immediate vicinity, the monument would be in plain sight of the east bank of the Hudson river from Sing Sing almost to Yonkers. The monument is in one piece, 11½ feet long and with a cross section of something over 1 x 2 feet. It weighs nearly 3 tons, and is set 4 feet down in an accurately cut hole in the rock and fastened with cement mortar, and is further supported for a foot and a half more by building stones and hydraulic mortar around it. The remaining portion (6 feet) is hammered, dressed and marked on two sides; the words "Boundary monument" and the date "1882" are cut on both sides. The north side is further marked:

NEW YORK:
HENRY R. PIERSON,
CHAUNCEY M. DEPEW,
ELIAS LEAVENWORTH,
COMMISSIONERS.
H. W. CLARKE,
SURVEYOR.

The south side is further marked:

NEW JERSEY.
ABRAM BROWNING,
THOMAS N. McCARTER,
GEORGE H. COOK,
COMMISSIONERS.
E. A. BOWSER,
SURVEYOR.

This monument stands on the property of the Palisade Land Company, and aside from having three of its corners chipped, it is in excellent condition.

MONUMENT No. 1, ON ROAD BETWEEN THE EASTERN WITNESS OR REFERENCE MONUMENT AND MILE-STONE "1."

This monument is situated on the west side of the boulevard which leads from Alpine, New Jersey, to the village of Palisades,

New York. It is at the east foot of the hill which rises about 15 degrees to its summit, distant about 100 paces, and is also 2,728 feet east of milestone "1." At the monument the following bearing was taken: South, 51 degrees, east 5 feet 1¼ inches to a white wood tree. Soil sandy. Disc set in lime. This monument has its southeast and northeast corners slightly chipped, otherwise was found to be in good condition.

MONUMENT No. 2 OR MILESTONE No. "1."

This monument is situated on the slope of a ridge between the boulevard and the road from Alpine to Palisades. It is about 971 feet east of monument No. 3, and stands just east of the edge of a large grove of trees on land belonging to Jacob S. Moore, and 25 paces north of a fence running up over the ridge. At the monument the following bearings were taken: South 85 degrees, west 18 paces to a large oak, and south 72 degrees, west 14 paces to another. Soil sandy. Disk set in leaves. This monument has its north corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 3 OR ROAD No. 1, BETWEEN MILESTONES "I" AND "II."

This monument is situated on the west side of the road which leads from Closter north to Palisades, and is about 971 feet west of milestone 1, and is on ground sloping eastward. At the monument the following bearing was taken: North 50 degrees, east 30 paces to a large oak which stands on the west side of the road about 100 feet south of David Manson's house. Soil sandy for a depth of 3 feet, when solid rock was encountered. Disc set in wood ashes. This monument has its southeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 4 OR ROAD No. 2.

This monument is situated on the west side of a road leading from Closter to Sparkill, and is about 2,992 feet west of milestone 1, and on ground sloping westward. At the monument the following bearings were taken: North by west 5 feet to a shade maple.

Soil sandy. Disc set in wood ashes. This monument leans very slightly to the north and has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 5 OR MILESTONE No. "II."

This monument is situated in the Tappen timber swamp, on the land of Jacob Blauveld, and is about 2,304 feet west of monument No. 4 and ten paces south of rail fence on ground which is low all around and at times covered with water. At the monument the following bearings were taken: South 51 degrees, east 6 paces to a hickory standing on "line;" also north 75 degrees, east 3 paces to a large oak. Soil clayey. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 6 OR ROAD No. 1 BETWEEN MILESTONES NOS. "II" AND "III" OR NORTHERN RAILROAD OF NEW JERSEY.

This monument is level with the surface of the ballast of the roadbed of the Northern Railroad of New Jersey, 2 feet 11 inches west of the westerly rail, and 104 feet 4 inches from the center (at the westerly end) of the center pier of the railroad bridge over small stream, Sparkill, it is also 1,501 feet west of milestone "II" 327 paces southeast of Tappan station. Disc is set in ashes from the railroad; the bottom and corners of the stone are badly chipped.

MONUMENT No. 7 OR ROAD No. 2.

This monument is situated on the west side of the road leading from Norwood to Tappan, just inside of wire fence, and is about 2,904 feet west of milestone "II" upon the edge of high ground bordering a little swamp and 130 paces north of highway bridge crossing Sparkill creek. At the monument the following bearing was taken: North 30 degrees, east 75 paces to the southwest corner of a barn which stands just east of the road. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 8 OR ROAD No. 3.

This monument is situated on the east side of the road leading from Schraalenburgh to Tappen, about 4,400 feet west of milestone "II" and on ground rising gently northwest. At the monument the following bearings were taken: North 76 paces to the southeast corner of the Dutch Methodist church, standing just east of the road; also about north 48 paces to the front entrance of Sonnebom's yard; also about 10 feet northerly to a cedar tree standing on the same side of the road. Soil sandy and somewhat stony. Disc set in wood ashes. This monument has its corners and edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 9 OR ROAD No. 4 OR WEST SHORE RAILROAD.

This monument is situated between the two westerly tracks of the West Shore railroad, about at the east foot of the slope rising to Andre hill, and 45 paces south 20 degrees west of Andre avenue. At the monument the following bearings were taken: North 50 degrees, west 67 paces to monument No. 10, and north 35 degrees, west 14 paces to a pin-oak tree. Soil sandy. Disc set in wood ashes. This monument has all four corners badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 10 OR ROAD No. 5 OR ANDRE AVENUE.

This monument is situated on the east side of Andre avenue, in front of land of James Bartow. It is about 5,051 feet west of milestone "II" and is 13 paces south of the westerly fence of the avenue and on the east slope of the hill. At the monument the following bearing was taken: North 10 degrees, west 30 paces to the middle house of three, which stands just north of the road or avenue. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 11 OR MILESTONE "III."

This monument is situated on the east slope of Andre hill, about 584 feet from the summit, or about half way up. At the monument the following bearings were taken: South 40 degrees, east 36 paces

to the southwest corner of a little white house and south 70 degrees, west 18 paces to an old well. Soil of fine gravel and somewhat wet. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 12 OR ROAD No. 1 BETWEEN MILESTONES "III" AND "IV."

This monument is situated on the top of Andre hill, about 584 feet west of milestone "III" on land of Bartow. At the monument the following bearings were taken: South 16 paces to the northwest corner of Bartow's house, and north 20 degrees west of Andre avenue. At the monument the following bearings were taken: North 50 degrees, west 67 paces to monument No. 10, and north 35 degrees west, 14 paces to a pin-oak tree. Soil sandy. Disc set in wood ashes. This monument has all four corners badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 13 OR ROAD No. 2.

This monument is situated on the north side of the road, leading from Tappan to Rivervale, about 1,825 feet west of milestone "III," and on ground comparatively level. It is 24 paces northwesterly of a small bridge which is the beginning point of two road districts, and 20 paces easterly of the entrance into Andrew Harring's barnyard. At the monument the following bearing was taken: North 51 degrees, west to Harring's house. Soil sandy. Disc set in cinders. This monument was found to be in good condition.

MONUMENT No. 14 OR MILESTONE "IV."

This monument is situated in an old apple orchard belonging to G. and P. DeWolf, and is opposite a small cedar tree. At the monument the following bearings were taken: North 55 degrees, west 13 paces to an apple tree, and north 10 degrees, west 22 paces to a white-wood tree. Soil sandy. Disc set in sand and monument in cement. This monument is 18 paces east from fence, and was found to be in good condition.

MONUMENT No. 15 OR ROAD No. 1, BETWEEN MILESTONES "IV" AND "V."

This monument is situated on the east side of the road leading from Rivervale to Orangeburgh, and running about north and south, is about 2,419 feet west of milestone "IV," 8 paces west of fence on east side of road and 11 paces south of a small bridge and on level ground. At the monument the following bearing was taken: North 10 degrees, east 111 paces to an old stone house owned by Samuel Harring. Soil somewhat gravelly. Disc set in light-colored sand. This monument was found to be in good condition.

MONUMENT No. 16 OR MILESTONE "V."

This monument is situated in the woods, about 50 paces west of a cleared lot, and about half way up the slope of a slight rise; it is also 5,261.27 feet west of milestone "IV," 20 paces west of an old wood road running north and south, and 140 paces south of the junction of this road and lane, leading westerly from house occupied by James Cassidy. At the monument the following bearing was taken: South 5 degrees, east 4 feet to an oak sapling. Soil sandy. Disc set in leaves. This monument was slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 17 OR ROAD No. 1, BETWEEN MILESTONES "V" AND "VI."

This monument is situated on the west side of a road running northeasterly and southwesterly, and leading to Blue Hill. It is also about 4,298 feet west of milestone "V," 68 paces south of the bridge and at the foot of a slight northerly slope. At the monument the following bearing was taken: North 80 degrees, east 138 paces to a large locust tree standing in Louis Dyett's front yard. Soil sandy and slightly gravelly. Disc set in wood ashes. This monument has its northeast and southwest corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 18 OR MILESTONE "VI."

This monument is situated on the east slope of the hill in the wood lot belonging to Louis Dyett and is 5,225.18 feet west of mile-

stone " V." At the monument the following bearings were taken: South 51 degrees, 9 feet east to a 12-inch elm tree, and north 42 degrees, east 11 paces to a hickory tree. Soil sandy. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 19 OR ROAD No. 1 BETWEEN MILESTONES " VI " AND " VII."

This monument is situated on the west side of a road running south 75 degrees east, and north 75 degrees west and is about 3,408 feet west of milestone " VI," and 13 paces north of an 18-inch ash tree and on ground sloping westward. At the monument the following bearings were taken: South 70 degrees, east 12 paces to a maple which stands between the east edge of the road and the stone fence; also, north 30 degrees, east 55 paces to a thorny locust tree which stands in the front yard of W. Comes. Soil sandy. Disc set in wood ashes. This monument has its northeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 20 OR MILESTONE " VII."

This monument is situated very near the summit of the first ridge west of the road in an orchard on the land of Mrs. Dutcher and is about 5,241 feet west of milestone " VI " and 1,833 feet west of monument No. 19; also, 13 paces from the westerly fence of the orchard. At the monument the following bearings were taken: North 65 paces to a large chestnut tree standing in the extreme southeast corner of the woods, and north 50 degrees, west 20 paces to another, the line also crosses the fence between the orchard and the woods at a distance of 130 paces northerly along the same from the lane. Soil sandy. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 21 OR ROAD No. 1 BETWEEN MILESTONES " VII " AND " VIII," OR THE NEW JERSEY AND NEW YORK RAILROAD.

This monument is situated on the west side of the track of the New Jersey and New York railroad, close in by the end of the ties

and about 1,640 feet west of milestone "VII" and about 880 paces along the track from the southeast corner of the depot at Pearl river, and in a slight cut. This monument has heaved 6 inches and has its corners badly chipped.

MONUMENT No. 22 OR ROAD No. 2.

This monument is situated on the west side of a road leading from Mount Vale to Pearl river and running about north and south, at the east foot of the hill, about 2,063 feet west of milestone "VII" and 385 feet west of monument No. 21; also, about 12 feet north of the corner of a line fence running about north 51 degrees west over the hill. At the monument the following bearing was taken: South 45 degrees, east 13 paces to the northwest corner of Buttock's barn. Soil sandy. Disc set in wood ashes. This monument has its east corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 23 OR MILESTONE No. "VIII."

This monument is situated in an open field belonging to Henry Blackwell on slightly rolling ground, it is about 5,251.25 feet west of milestone "VII" and about 250 paces west of the nearest point of the Pascack creek. At the monument the following bearings were taken: South 70 degrees, west 15 paces to an apple tree and south 15 degrees, east 90 paces to a chestnut tree standing in the corner of the field. Soil sandy. Disc set in sand and the monument in cement. This monument was found to be in good condition.

MONUMENT No. 24 OR ROAD No. 1 BETWEEN MILESTONES "VIII" AND "IX."

This monument is situated on the east side of the road, which runs north and south, and is about 449 feet west of milestone "VIII" and about 10 feet north of a small stream on ground sloping eastward. At the monument the following bearing was taken: South 24 paces to the northwest corner of a house standing just east of the road. Soil very gravelly and the hole full of water. Disc set in wood ashes. This monument has heaved 4 inches; otherwise it was found to be in good condition.

MONUMENT No. 25 OR ROAD No. 2.

This monument is situated on the north side of the road, running nearly east and west, just at the top of a hill, about 2,320 feet west of milestone "VIII" and about 9 paces west of rail fence running northerly. At the monument the following bearings were taken: South 50 degrees, east 12 paces to a birch tree, and south 9 paces to a chestnut tree standing just inside of the fence and near the bars. Soil sandy. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 26 OR ROAD No. 3.

This monument is situated on the west side of the road, about 3,492 feet west of milestone "VIII" and about opposite the point at which a road running north and south enters the main road on which the monument is set. The main road runs from Manuette to Saddle river and the cross road to Pearl river. At the monument the following bearings were taken: South 50 degrees, east 22 paces to a small white oak standing just inside of the fence and at the intersection of the roads, and north 51 degrees, west about 500 feet to the house at the top of hill. Soil somewhat gravelly and much water in the hole. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 27 OR ROAD No. 4.

This monument is situated on the west side of the road, which runs about north and south, leading from Hackensack to Spring Valley, and is about 109.51 feet east of milestone "IX" and on level ground, 100 paces from Daniel A. Post's house. At the monument the following bearings were taken: South 18 degrees, west 70 paces to a butternut tree which stands just in the angle of the fence, and north 18 degrees, east 93 paces to the southeast corner of an old building belonging to Mr. Post and standing just west of the road. Soil sandy. Disc set in wood ashes. This monument has heaved 5 inches, otherwise it was found to be in good condition.

MONUMENT No. 28 OR MILESTONE No. "IX."

This monument is situated in an open field on the property of Mr. Post and on level ground. At the monument the following

bearings were taken: North 51 degrees west 115 paces to Post's house, and south 92 paces to the butternut tree described in the preceding description. Soil sandy. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 29 OR ROAD No. 1 BETWEEN MILESTONES "IX" AND "X."

This monument is situated on the west side of the road running about north and south, and is about 318 feet east of milestone "X" and on level ground. At the monument the following bearings were taken: South 20 degrees, west 55 paces to the southeast corner of Leadwith's house, and north 32 degrees, east 80 paces to the northeast corner of John A. Christopher's house. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 30 OR MILESTONE No. "X."

This monument is situated in an open field on the property of Mr. Leadwith, and just a little on the westerly slope of a slight rise, and is about 5,286.6 feet west of milestone "IX." At the monument the following bearings were taken: South 26 degrees, east 135 paces to the northwest corner of Leadwith's house, and south 78 degrees, west 92 paces to a chestnut tree. Soil sandy. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 31 OR ROAD BETWEEN MILESTONES "X" AND "XI."

This monument is situated on the east side of the road leading from Saddle river and running south 20 degrees west and north 20 degrees east. It is about 4,050 feet west of milestone "X" and on ground sloping gently westward to Saddle river, distant about 270 paces and under barbed wire fence. At the monument the following bearings were taken: North 55 degrees, west 16 paces to an apple tree standing just inside of the fence, and north 11 degrees, west 37 paces to the southeast corner of Michael Connoly's barn. Soil gravelly and sandy and hole very wet. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 32 OR MILESTONE No. "XI."

This monument is situated in a little cedar grove belonging to Van Buskirk, and is 5,267.6 feet west of milestone "X" and about 1,217 feet west of monument No. 31, on ground ascending westward, 15 paces from the rail fence separating young apple orchard from cedar grove and 45 paces easterly from a small shed. Soil sandy and somewhat stony. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 33 OR ROAD No. 1 BETWEEN MILESTONES "XI" AND "XII."

This monument is situated on the west side of the road which runs north 75 degrees west and south 75 degrees east; it is about 2,258 feet west of milestone "XI" and on the west slope of a hill near the top. At the monument the following bearings were taken: North 75 degrees, west 20 feet to a large chestnut tree standing just north of the road, and south 84 degrees, east 32 paces to the southwest corner of J. B. Degraw's house, which stands north of the road and about at the top of the hill. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 34 or ROAD No. 2.

This monument is situated on the east side of a road which runs northeast and southwest, and is 3,585 feet west of milestone "XI" and about at the foot of the hill adjoining lands of Margaret DeBarry. At the monument the following bearings were taken: South 52 degrees, west 40 paces to an apple tree, and north 25 degrees, east to a buttonwood tree which stands near a bridge, and on the east bank of a stream, also 5 paces to the nearest point on said stream, and 20 paces south along the road to a point where it makes a right angle and runs eastward up the hill. Soil sandy. Disc set in wood ashes. This monument was chipped on south edge, otherwise it was found to be in good condition.

MONUMENT No. 35 OR ROAD No. 3.

This monument is situated on the west side of the River Valley road, which runs about north and south, and is about 4,083 feet

west of milestone "XI" and on the east slope of a hill. At the monument the following bearing was taken: South 10 degrees, west to the northeast corner of an old barn which stands directly opposite the junction of roads leading to Tallmans and Suffern. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 36 OR MILESTONE No. "XII."

This monument is situated in a wood lot belonging to Cornelius Snyder at the west foot of the hill, about 25 paces north, 51 degrees west from the corner of the line fence which ends at the woods and 23 paces southwest of bars in fence running northerly. At the monument the following bearing was taken: North 16 paces to an oak tree standing near a fence running east and west. Soil sandy. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 37 OR ROAD No. 1 BETWEEN MILESTONES "XII" AND "XIII."

This monument is situated at the top of a hill and on the east side of a road running north and south from Saddle river to Tallmans and is about 3,304 feet west of milestone "XII." At the monument the following bearings were taken: South 23 degrees, east 12 paces to the northwest corner of James Fox's house, and north 22 degrees, east 17 paces to an old apple tree. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 38 OR MILESTONE No. "XIII."

This monument is situated on the west slope of a hill in a young peach orchard, the property of Louis H. Doremus, and north 50 paces to a small white oak standing in the southwest corner of the field. Soil sandy. Disc set in sand and monument in cement. This monument has its top almost flush with the ground, otherwise it was found to be in good condition.

MONUMENT No. 39 OR ROAD No. 1 BETWEEN MILESTONES "XIII" AND "XIV."

This monument is situated at the west foot of the hill and on the east side of a road running north 40 degrees, east and south 40 de-

grees west, and is about 673 feet west of milestone "XIII." At the monument the following bearings were taken: South 18 degrees, east 30 paces to the northwest corner of Doremus house and north 10 paces to a whitewood tree standing on the opposite side near a large boulder. Soil coarse gravel. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 40 OR ROAD No. 2.

This monument is situated at about the east foot of a hill and on the west side of a road which runs north 20 degrees east and south 20 degrees west, and is about 2,782 feet west of milestone "XIII." At the monument the following bearings were taken: North 20 degrees, east 90 paces to a corner of a line fence between W. W. Way and adjoining land, and south 48 degrees, east 8 paces to a wild cherry tree standing in the corner near a line fence. Soil sandy. Disc set in wood ashes. This monument has heaved 2 inches, otherwise it was found to be in good condition.

MONUMENT No. 41 OR MILESTONE "XIV."

This monument is situated near the edge of the woods on the west slope of the hill and 5,298 feet west of milestone "XIII." At the monument the following bearings were taken: South 42 degrees, east 9 paces to a white oak tree, and south 50 degrees, west 9 paces to a red oak tree; also about one-half mile west of W. W. Way's house, and at the corner of his land and David Fox's, Way's fence running westerly and Fox's running northerly. Soil sandy. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 42 OR ROAD No. 1 BETWEEN MILESTONES "XIV" AND "XV."

This monument is situated on the south side of a private road or lane leading up to Colonel David Fox's house, and is 3,434 feet west of milestone "XIV" and on level ground outside of wire fence. At the monument the following bearings were taken: North 85 degrees, east 190 paces to a large oak tree standing just outside of the yard's limit, and south 85 degrees, west 5 paces to

a shade maple tree. Soil sandy. Disc set in sand, and monument being broken was set in cement. This monument was slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 43 OR ROAD No. 2.

This monument is situated on the east side of the old Ramapo post road, which runs about north and south, and is about 4,705 feet west of milestone "XIV." At the monument the following bearing was taken: South 215 paces to the bridge over the Mahwah river; also about 1 pace south of the corner of David Fox's line fence. Soil sandy. Disc set in ashes from the railroad. This monument is slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 44 OR ROAD No. 3, OR THE NEW YORK, LAKE ERIE AND WESTERN RAILROAD.

This monument is situated between the two main tracks of the New York, Lake Erie and Western railroad, about 46 paces west of monument No. 43 and 4,839 feet west of milestone "XIV." The slag or stone ballast of the railroad covers this monument to a depth of about 1 foot. Soil a mixture. Disc set in ashes from the railroad. Aside from this monument being covered to the depth of about 1 foot with the ballast of the railroad, it was found to be in good condition.

MONUMENT No. 45 OR MILESTONE No. "XV."

This monument is situated in an open field upon the land of Dr. Zabriskie and is about 5,280 feet west of milestone "XIV" on level ground, about 25 paces westerly of rail fence running northeasterly. At the monument the following bearings were taken: South 60 degrees, east 35 paces to an apple tree, and north 50 degrees, east about 75 paces to Zabriskie's house. Soil sandy. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 46 OR ROAD No. 1, BETWEEN MILESTONES "XV" AND "XVI."

This monument is situated on the east side of the road which runs north and south along the east foot of the Ramapo moun-

tains, and is about (no distance given in original report) west of milestone "XV." At the monument the following bearing was taken: South 60 degrees, east 100 paces to the house of Owen DeGroot (colored), and north about 6 feet to a butternut tree standing opposite the end of a line fence. Soil sandy. Disc set in wood ashes. This monument has its southwest corner chipped down from the top a distance of about 10 inches and its other corners slightly chipped.

MONUMENT No. 47 or MILESTONE No. "XVI."

This monument is situated about half way up the east slope of the Ramapo mountain and 10 feet east of a wood road which leaves the main road opposite the house of Owen DeGroot, about 10,463 feet west of milestone "XIV" and about 200 feet westerly on line from the cabin of Peter Mann. At the monument the following bearing was taken: North 65 degrees, east to the spire of the Episcopal Church in Suffern. Soil sandy until about 6 inches of the full depth, when a rock ledge was encountered on which was cut a cross in place of the disc. This monument was found to be in good condition.

MONUMENT No. 48 OR MILESTONE No. "XVII."

This monument is situated on the east slope of a ridge and just on the southeast edge of a little clearing, and is 5,141.65 feet west of milestone "XVI" and 9 paces northwest of path. At the monument the following bearings were taken: North 65 degrees, west 250 paces to a chestnut tree standing in the dooryard just north of John DeGroot's house, and north 15 degrees, west 3 paces to a large white oak stump 6 feet high. Soil very rocky. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 49 OR MILESTONE No. "XVIII."

This monument is situated in an open field belonging to the Pierson estate, and about half way down a gradual slope which begins at the mountain, on the southeast, and slopes westward. It is 5,301.2 feet west of milestone "XVII." At the monument the following bearings were taken: North 85 degrees, east 9 paces

to a maple, and north 18 degrees, west about 20 paces to an apple tree, also about 200 paces northerly to Mrs. Mann's house. Soil gravelly. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 50 OR ROAD No. 1, BETWEEN MILESTONES "XVIII" AND "XIX."

This monument is situated on the east side of a road running north 30 degrees east, and south 30 degrees west through the valley. The monument is about 10 paces north of a large bowlder, having blazed trees all about it. The bowlder is of the following dimensions: About 12 feet long, 6 feet high and 10 feet wide. Soil sandy. Disc set in leaves. This monument is 156 paces southwest along said road from center of bridge over small stream and 197 paces from big bowlder at forks of same road, and one that goes up the hill. This monument has heaved 6 inches, otherwise it was found to be in good condition.

MONUMENT No. 51 OR MILESTONE No. "XIX."

This monument is situated very near the top of the ridge between Negro and Shepherd ponds, on land belonging to Charles Morris. At the monument the following bearings were taken: South 75 degrees, west 3 feet to a small white oak, and north 75 degrees, east 3 paces to a hickory. The house which stands on the northwest corner of Shepherd pond bears north 50 degrees west. Soil sandy until about 6 inches of the required depth, where a ledge of rock was encountered on which a mark was cut in place of the disc. This monument is slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 52 OR ROAD No. 1, BETWEEN MILESTONES "XIX" AND "XX."

This monument is situated in the woods about 60 paces west of milestone "XIX," and a little on the west slope of the ridge, and on the east side of an old road which runs north 30 degrees east and south 30 degrees west. At the monument the following bearings were taken: East 2 paces to a chestnut tree and west 5 paces

to another. Soil fine sand. Disc set in leaves. This monument has its west corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 53 OR ROAD No. 2.

This monument is situated near the top of the first hill west of Shepherd pond and on the east side of the road, now but little used, running north 20 degrees east and south 20 degrees west, about 4,023 feet west of milestone "XIX," and on south side of line worm fence. At the monument the following bearing was taken: North 51 degrees, west about 2 paces to a hickory stump about 5 inches in diameter, which was exactly on line. Soil sandy. Disc set in wood ashes. This monument has its northeast corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 54, OR MILESTONE No. "XX" AND COUNTY STONE,

This monument is situated in a wet meadow, about 80 paces west of the edge of the woods which skirt the meadow and is 5227.4 feet west of milestone "XIX" and in a line fence between the land of Abram S. Hewitt and Colonel Payne. It marks the corner of the counties of Rockland and Orange, N. Y. At the monument the following bearing was taken: South 58 degrees, east 75 paces to a large oak which, about 7 feet from the ground, divides into two trunks. Soil about 2 feet turf, 2 feet blue clay, and the balance good solid sandy gravel; hole filled with water, but the monument is firmly set in cement and the disc put in as usual. This monument was found to be in good condition.

MONUMENT No. 55, OR ROAD No. 1, BETWEEN MILESTONES "XX" AND "XXI."

This monument is situated in the valley on the west side of a road which runs north 45 degrees east, and south 45 degrees west, it is about 2,544 feet west of milestone "XX" and 5 paces north of a small brook. At the monument the following bearing was taken: North 65 degrees, east 60 paces to the southeast corner of a frame house. Soil gravelly and many boulders; hole filled

with water. Disc set in wood ashes. This monument has the east corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 56 OR MILESTONE No. "XXI."

This monument is situated on the west slope of a high ridge, and is just on the south edge of a small clearing and on the west edge of a wood road belonging to Abram S. Hewitt. At the monument the following bearing was taken: South 51 degrees, east 4 paces to an 18-inch white ash tree standing on line. Soil sandy. Disc set in leaves. This monument was found to be in good condition.

MONUMENT No. 57 OR ROAD No. 1, BETWEEN MILESTONES "XXI" AND "XXII."

This monument is situated on the west slope of the mountain, and on the east side of a wood road leading from Ringwood to Sterling Furnace, which runs south 85 degrees east, and north 85 degrees west, and is about 100 paces west of milestone "XXI." At the monument the following bearing was taken: North 85 degrees, west 9 paces to a white oak tree standing on the west edge of the road. Soil sandy. Monument was broken in getting it to the place, and in consequence was only set about 2 feet, but very firmly. This monument was found to be in good condition.

MONUMENT No. 58, OR MILESTONE No. "XXII."

This monument is situated in the woods on the southeast slope of a hill which appears to be a projection from the Black Rock mountain; it is 5258.46 feet west of milestone "XXI" and just on the edge of a lot of large rocks. At the monument the following bearings were taken: North 53 degrees, west about 20 paces to the large boulder which caps the south end of Black Rock mountain, and south 48 degrees, east about 4 paces to a small black oak, also south 32 degrees, east 16 paces to twin white oak 10 inches in diameter, which separates about 2 feet above ground. Very rocky all about, and in consequence a mark was cut in place of disc. This monument was found to be in good condition.

MONUMENT No. 59 OR ROAD No. 1 BETWEEN MILESTONES "XXII" AND "XXIII."

This monument is situated in the valley between Black Rock and Beach mountains; it is about 4,012 feet west of milestone "XXII" and on the east side of a road which runs south 80 degrees west and north 80 degrees east. At the monument the following bearing was taken: North 72 degrees, west 30 paces to a whitewood tree and an elm which stand on the edge of a swamp; also about 17 paces east of a small bridge. Solid rock was encountered and no disc was used. This monument was found to be in good condition.

MONUMENT No. 60 OR MILESTONE No. "XXIII."

This monument is situated in a swamp, but on ground somewhat higher, about the foot of Beach mountain, in thick, young woods. At the monument the following bearings were taken: South 20 degrees, west about 1,000 feet to the house of Mr. Patterson, on Beach farm, and south 24 degrees, east 25 paces to an oak which stands on the southwest corner of a small clearing where now stands the ruins of an old house; it is 4,586 feet west of milestone "XXII" and at the foot of two birch trees. Soil sandy. Disc set in leaves. This monument was found to be in good condition.

MONUMENT No. 61 OR MILESTONE No. "XXIV."

This monument is situated on the west slope of Beach mountain, about half way down, and on the west side of a road running about north and south, which at this point runs down hill toward the north; it is also 5,197 feet west of milestone "XXIII." At the monument the following bearing was taken: South 67 degrees, west 40 paces to a large chestnut tree which stands just on the east edge of a wood road which leaves the main road near the monument. Soil sandy. Disc set in leaves. This monument was found to be in good condition.

MONUMENT No. 62 OR MILESTONE No. "XXV."

This monument is situated on the west slope of the first ridge east of Greenwood lake and in the northwest corner of a swamp; it is also 5,247.4 feet west of milestone "XXIV." At the monu-

ment the following bearings were taken: North 55 degrees, east 5 paces to an oak, and south 48 degrees, east 60 paces to an elm; also about south 75 degrees east to a large prominent rock. Soil clay and somewhat wet. No disc used. This monument was found to be in good condition.

MONUMENT No. 63 OR ROAD No. 1, OR THE NEW YORK AND GREENWOOD LAKE RAILWAY.

This monument is situated at the west foot of the ridge on the east side of the New York and Greenwood Lake railroad track, and is about 2,525 feet west of milestone "XXV" and 15 paces east of the edge of Greenwood lake. At the monument the following bearings were taken: North 40 degrees, east about 75 paces to the southeast corner of Ryerson's house, and south 40 degrees, west 56 paces to the northeast corner of the railroad station. Soil sandy. Disc set in ashes from the railroad. This monument leans slightly to the north and has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 64 OR MILESTONE No. "XXVI."

This monument is situated at the east foot of Rough mountain 5,282 feet west of milestone "XXV" and southeast 16 paces from the southeast corner of the Hohokus clubhouse. At the monument the following bearings were taken: North 23 degrees, west 65 paces to a large sugar maple tree which stands 10 paces west of the road, and south 70 degrees, west 50 paces to another tree which stands 10 paces east of the road. Soil gravelly. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 65 OR ROAD No. 1, BETWEEN MILESTONES "XXVI" AND "XXVII."

This monument is situated on the west side of the road which runs north 20 degrees east and south 20 degrees west along the east foot of Rough mountain, and is about 50 paces west of milestone "XXVI." At the monument the following bearings were taken: North 12 degrees, east 50 paces to a sugar maple tree, and south 5 degrees, west 59 paces to another tree (both of which are mentioned

in the preceding description), also 760 paces along the road to the Lake Side House. Soil quite slatey. Disc set in charcoal. This monument is slightly chipped along its southerly edge, otherwise it was found to be in good condition.

MONUMENT No. 66 OR MILESTONE No. "XXVII."

This monument is situated on Rough mountain about 300 paces west of the last or highest ridge, and on the west edge of a bad swamp, and is distant 5,047.7 feet west of milestone "XXVI." At the monument the following bearings were taken: South 9 degrees, east 6 paces to a white oak tree, and north 30 degrees, east about 100 feet to the outlet of the swamp, also 1 pace southerly to a pine tree. Soil sandy, though apparently rocky everywhere else; cross cut on the ledge in place of disc. This monument was found to be in good condition.

MONUMENT No. 67 OR MILESTONE No. "XXVIII."

This monument is situated about half way up the easterly slope of a steep hill in thick young woods, 10 feet north of an old line fence and 100 paces north of a cleared field, and distant 5,161 feet west of milestone "XXVII." At the monument the following bearings were taken: South 5 degrees, east 5 paces to a small hickory standing in the line fence, and south 40 degrees, west to an old tumble-down house standing on the north side of the lane which leads up by Springer's house. This monument was found to be in good condition.

MONUMENT No. 68 OR ROAD No. 1, BETWEEN MILESTONES "XXVIII" AND "XXIX."

This monument is situated on the west side of a road which runs north 20 degrees east and south 20 degrees west, along the west slope of the ridge, and is distant 1,295 feet west of milestone "XXVIII." At the monument the following bearings were taken: South 20 degrees, west about 90 feet to a large chestnut standing in the stone fence, and north 20 degrees, east about 110 feet to another, also 200 paces southerly along the road to the lane leading to Springer's house. Soil gravelly and some slate. Disc set in

sand. This monument is chipped along its southerly edge and has its southeast corner broken, otherwise it was found to be in good condition.

MONUMENT No. 69 OR MILESTONE No. "XXIX."

This monument is situated about half way down the westerly slope of a steep hill in an open field of land of Mr. Wright, and is distant 5,232.8 feet west of milestone "XXVIII." At the monument the following bearings were taken: South 50 degrees, west 50 paces to a large buttonwood tree, and north 19 degrees, west 400 paces to the southeast corner of Wright's house. Soil sandy. Disc set in sand, and monument in cement. This monument was found to be in good condition.

MONUMENT No. 70 OR ROAD NO. 1, BETWEEN MILESTONES "XXIX" AND "XXX."

This monument is situated on the west side of a road which runs north 40 degrees east and south 40 degrees west and is distant about 1,813 feet west of milestone "XXIX" and about at the west foot of the slope. At the monument the following bearings were taken: North 50 degrees, east 240 paces to a small house standing opposite the junction of the roads and south 40 degrees, west 100 paces to the northeast corner of tenanthouse of Erastus Horton, also about 40 paces southerly along the road to a bridge. Soil sandy. Disc set in wood ashes. This monument has heaved three inches, otherwise it was found to be in good condition.

MONUMENT No. 71, OR MILESTONE No. "XXX."

This monument is situated on top of a mountain and on the east slope of a ridge, about 30 paces west of an old wood road which runs between this ridge and one a little farther west, 5,325 feet west of milestone "XXIX" and 40 paces west of the west end of worm line fence. At the monument the following bearings were taken: North 51 degrees, west 7 paces to a large oak stump, and southerly 4 feet to a small hickory stump 6 inches in diameter, 5 feet long, standing alone. Soil sandy. Disc set in leaves. This monument was found to be in good condition.

MONUMENT No. 72 OR ROAD No. 1, BETWEEN MILESTONES "XXX" AND "XXXI."

This monument is situated 25 feet east of the east side of a road which runs north 40 degrees east and south 40 degrees west through the hollow; it is distant about 1,020 feet west of milestone "XXX" and 5 paces easterly of the point where the brook crosses the road and at the west foot of the hill. At the monument the following bearings were taken: North 68 degrees, west 20 paces to a large hemlock tree, and south 65 degrees, east 13 paces to a chestnut tree, also 3 paces to a black oak tree. Soil sandy but very stiff and hard towards the bottom. No disc used. This monument was found to be in good condition.

MONUMENT No. 73 OR ROAD No. 2.

This monument is situated on the east side of a road running about north and south, and about at the top of a hill, and is distant 2,260 feet west of milestone "XXX." At the monument the following bearings were taken: North 8 degrees, west 83 paces to a large hickory tree which stands just on the roadside in front of the residence of John W. House, and north 58 degrees, west 22 paces to an apple tree standing in the orchard west of the road. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 74 OR MILESTONE No. "XXXI."

This monument is situated in an open field on the land of Millard Wallace, and on the gentle west slope of the hill, 5,280 feet west of milestone "XXX" and 27 paces west of stone fence standing on west side of lane leading past Wallace's barn. At the monument the following bearing was taken: North 44 degrees, east 165 paces to the southeast corner of Wallace's barn. Soil sandy. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 75 OR ROAD No. 1, BETWEEN MILESTONES "XXXI" AND "XXXII."

This monument is situated on the west side of a road running about north and south and sloping towards the north, and is dis-

tant 8,629.8 feet west of milestone "XXX." At the monument the following bearings were taken: North 7 degrees, east 425 paces along the road to the house of Levi Belden, which stands at the junction of the road, and north 76 degrees, west 8 feet to a pear tree standing just inside of the stone wall. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 76 OR ROAD No. 2.

This monument is situated on the west side of a road running north 78 degrees west and south 78 degrees east, and in front of and near the northeast corner of a picket fence and between two shade trees, 6 feet 9 inches south of one and 19 feet 9 inches north of the other. At the monument the following bearings were taken: North 33 degrees, west 82 paces to the northeast corner of Mr. Welling's house and south 88 degrees east to another house near the intersection of the road. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 77 OR MILESTONE No. "XXXII."

This monument is situated in an open field belonging to Mr. William R. Welling, about 3 paces east of a lane running from his house down across the Wawayanda, and is distant 5,317 feet west of milestone "XXXI." At the monument the following bearings were taken: South 34 degrees, east about 75 paces to the northwest corner of the main barn, and north 85 degrees, west 110 paces to a large hickory tree which stands in the southeast corner of a field and just opposite an angle in the lane; also south 80 degrees, east 40 paces to a large hickory tree distant 9 paces from the lane. Soil sandy. Disc set in sand and monument in cement. This monument has its northwest corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 78 OR ROAD No. 1, BETWEEN MILESTONES "XXXII" AND "XXXIII" ON LEHIGH AND HUDSON RIVER RAILROAD.

This monument is situated on the west side of the track of the Lehigh and Hudson River Railroad, and is distant about 2,367 feet

west of milestone "XXXII." At the monument the following bearings were taken: South 88 degrees, east 100 paces to an elm tree which stands in the field about 100 paces south of the track, and south 64 degrees, east 100 paces to a hickory tree, and south 23 degrees east to an elm tree, also about 17 feet southerly along the railroad to the northerly abutment of the cattle pass. Soil sandy. Disc set in ashes from the railroad. This monument has one of its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 79 OR ROAD No. 2.

This monument is situated on the east side of a road running north 70 degrees east, and south 70 degrees west on ground comparatively level, and is distant about 4,060 feet west of milestone "XXXII." At the monument the following bearings were taken: South 65 degrees, west 363 paces along the road to the northeast corner of Alfred Ely's house, and north 35 degrees, west 25 paces to a butternut tree, and north 40 degrees, west 20 paces to another tree, also 263 paces along the road to where a brook crosses just at the junction of the road. Soil slatey. Disc set in wood ashes. This monument has the east edge slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 80, OR ROAD No. 3.

This monument is situated on the west side of a road which runs north 25 degrees east, and south 25 degrees west, and at the east foot of a hill, and is distant about 4,616 feet west of milestone "XXXII." At the monument the following bearings were taken: North 51 degrees, west 4 feet to a large live oak tree, and north 60 degrees, east 65 paces to an elm tree, and east 25 paces to a butternut tree: Also 350 paces along the road to Ely's house. Soil sandy, with slate rock bottom. Disc set in wood ashes. This monument has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 81 OR MILESTONE No. "XXXIII."

This monument is situated on the east slope of a ridge, and just a little on the south side of a line fence on the property of A. Ely.

and is distant 5,355 feet west of milestone "XXXII." At the monument the following bearings were taken: North 51 degrees, west 5 paces to a large white oak on line, 10 paces east to a large black walnut tree, and south 51 degrees east to a butternut tree, also, south about 300 paces to Ely's house. Monument set in rock excavation, with cross cut on the bottom in place of disc. This monument was found to be in good condition.

MONUMENT No. 82 OR ROAD No. 1, BETWEEN MILESTONES "XXXIII" AND "XXXIV."

This monument is situated on the west side of a road running north 50 degrees east, and south 50 degrees west, and on the top of a low bridge, about 4,354 feet west of milestone "XXXIII." At the monument the following bearings were taken: South 40 degrees, west 150 paces to the house of Mr. Forsher, also about 3 feet to the corner of a line fence. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 83 OR MILESTONE No. "XXXIV."

This monument is situated in an open swampy field 200 feet west of west end of line fence on land of Mr. Layton, 5,280 feet west of milestone "XXXIII" and east of Pochuck meadow. At the monument the following bearings were taken: South 5 degrees, west 250 paces to the northwest corner of Layton's house, and north 51 degrees, west 95 paces to a buttonwood tree standing on line. Disc set in fine gravel. This monument projects about 12 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 84 OR MILESTONE No. "XXXV."

This monument is situated in an open field on swampy low land about 100 paces east of the edge of the upland and the west edge of Pochuck meadow, 10 feet north of line fence, on the property of Linn Roy, and 5,351.5 feet west of milestone "XXXIV." At the monument the following bearings were taken: North 10 degrees, west to Mr. Roy's house, and south 10 degrees, east 6 paces to a pin oak tree standing on the south bank of a line brook.

This tree is not notched or blazed. Soil soft and mushy. Disc set in sand and monument in cement. This monument projects about 12 inches above the ground and has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 85 OR ROAD No. 1, BETWEEN MILESTONES "XXXV" AND "XXXVI."

This monument is situated on the east side of a road running about at right angles to the line and on east slope of the Pochuck mountain, about 9 feet north of line fence and 700 feet west of milestone "XXXV." At the monument the following bearings were taken: South 50 degrees, east 50 paces to an elm tree standing in the fence, and south 24 degrees, west 70 paces to another on the east edge of the road. Soil sandy. Disc set in sand. This monument was found to be in good condition.

MONUMENT No. 86 OR MILESTONE No. "XXXVI."

This monument is situated in an open field on the east slope of the Pochuck mountain, and on the property of the Bush estate, and is distant 5,270 feet west of milestone "XXXV." At the monument the following bearings were taken: North 49 degrees, east 40 paces to the southeast corner of the tenanthouse of Thomas J. Ryerson, and south 64 degrees, east 40 paces to a large chestnut tree, also about south 55 degrees, east to a black walnut tree. Soil sandy. Disc set in wood ashes. This monument projects 9 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 87 OR MILESTONE No. "XXXVII."

This monument is situated in a ravine between two peaks of the Pochuck mountain, and on the west slope of the ridge, just on the north edge of a swamp, on lands of Drake & Stratton, and is distant 5,147.7 feet west of milestone "XXXVI." At the monument the following bearings were taken: South 51 degrees, east 25 feet to a live oak tree about 6 inches in diameter, and north 76 degrees, west 5 paces to another standing about 30 feet south of the road leading to the orchard; following this road east-

erly about 100 paces it opens into an apple orchard. Soil sandy. Disc set in leaves. This monument projects about 9 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 88 OR ROAD No. 1 BETWEEN MILESTONES "XXXVII" AND "XXXVIII."

This monument is situated on the westerly side of the road which runs north 43 degrees east and south 43 degrees west. and about at the west foot of the Pochuck mountain, and is distant about 3,651 feet west of milestone "XXXVII." At this monument the following bearings were taken: North 8 degrees, east 7 paces to a cherry tree standing just inside of the fence, and south 46 degrees, west 200 paces to the northeast corner of Levine Potter's house. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 89 OR MILESTONE No. "XXXVIII."

This monument is situated in the meadow land east of the Wallkill river, north side of line fence, and 5,247.7 feet west of milestone "XXXVII." At the monument the following bearings were taken: North 16 degrees, west 63 paces to a maple tree standing on the west bank of a ditch, which begins at east of and runs at right angles to the willows which skirt the road running across the Wallkill, also north 85 degrees east to Yarrington's house which stands on Liberty corner. This monument is also in the line fence between the lands of Levine Potter and Drake & Stratton. Soil about 1 foot muck and the balance white sand. Disc set in sand and the monument in cement. This monument projects about 15 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 90 OR MILESTONE No. "XXXIX."

This monument is situated on the east slope of and about 50 paces from the foot of the ridge west of the Wallkill lowlands, in a stone fence, and at junction of worm fence running southerly, and 3 feet south of small shanty on the line between the lands of Charles Tuttle and G. VanGelder, and is distant 5,278.7 feet west

of milestone "XXXVIII." At the monument the following bearings were taken: South 70 degrees, east 48 paces to an oak tree standing in the edge of the lowlands, and north 55 degrees, west 5 paces to an oak stump standing just south of the fence. Disc set in wood ashes. This monument projects 12 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 91 OR ROAD No. 1 BETWEEN MILESTONES "XXXIX" AND "XL."

This monument is situated on the west side of the road which runs north 40 degrees east and south 40 degrees west, and about at the west foot of a steep hill, and is distant about 2,100 feet west of milestone "XXXIX," and about 250 feet north of road running westerly. At the monument the following bearings were taken: North 40 degrees, east 425 paces along the road to Charles H. Tuttle's house, and north 30 degrees, west to Mr. Clark's house; also north 60 degrees, east 40 paces to a cherry tree. Soil sandy. Disc set in wood ashes. This monument has heaved 7 inches, otherwise it was found to be in good condition.

MONUMENT No. 92 OR ROAD No. 2.

This monument is situated on the south side of a road which runs south 50 degrees east, and is about 100 paces along the same, west of the top, and is distant about 4,173 feet west of milestone "XXXIX." The road referred to follows the boundary on the southwest side thereof nearly to milestone "XL." At the monument the following bearings were taken: South thirty degrees, west about 250 paces to a house standing in a hollow, and north 51 degrees, west to a large line tree. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 93 OR MILESTONE No. "XL."

This monument is situated near the bottom of the west slope of the hill in an apple orchard, the land of Peter Kimber, and is distant 5,229.9 feet west of milestone "XXXIX," and 30 feet south of road. At the monument the following bearings were taken: North 78 degrees, west 58 paces to a butternut tree, and north 60 degrees,

west 200 paces to Kimber's mill. Also about 100 paces to the intersection of the road. Disc set in sand and monument in cement. This monument was found to be in good condition.

MONUMENT No. 94 OR ROAD No. 1, BETWEEN MILESTONES "XL" AND "XLI."

This monument is situated on the north side of the road which runs nearly north and south, and about 100 paces east of the west foot of the hill, and is distant about 278 feet west of milestone "XL." At the monument the following bearings were taken: North 60 degrees, west 100 paces to the northeast corner of Kimber's mill, and south 5 degrees, east 70 feet to a butternut tree, also just opposite the intersection of the road. Soil sandy. Disc set in wood ashes. This monument leans slightly to the south, otherwise it was found to be in good condition.

MONUMENT No. 95, OR ROAD No. 2, OR THE NEW YORK, SUSQUEHANNA AND WESTERN RAILROAD.

This monument is situated at the west side of the track of the New York, Susquehanna and Western railroad, about 3 feet from the westerly rail, and just about at the north end of a slate cut, and 500 paces west of milestone "XL." At the monument the following bearings were taken: North 45 degrees, east 225 paces to the southeast corner of a barn which stands on the lower road just at the entrance to a lane and north 50 degrees, west 30 paces to an apple tree. Disc set in wood ashes. This monument projects 13 inches above the ground and leans slightly to the south, otherwise it was found to be in good condition.

MONUMENT No. 96 OR ROAD No. 3.

This monument is situated on the east side of a road running north 25 degrees east, and south 25 degrees west, and is distant 2,122 feet west of milestone "XL" and about 4 paces west of the west edge of a mill pond. At the monument the following bearings were taken: North 45 degrees, east 40 paces to the southwest corner of a sawmill and south 45 degrees, east 30 paces to a wild cherry tree standing just on the east bank of a pond, also about

20 paces southerly to the intersection of the road. Soil sandy for one foot, but very hard and stiff. Slate in the bottom. Disc put in the side and a mark cut on the rock. This monument leans slightly to the southeast, and has northeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 97 OR ROAD NO. 4.

This monument is situated on the west side of a road which runs north 35 degrees, east, and south 35 degrees, west, and about at the west foot of a hill, and distant about 5,083 feet west of milestone "XL." At the monument the following bearings were taken: North 35 degrees, east 83 paces to a white oak tree standing just east of and opposite the intersection of the roads and south 35 degrees, west 75 paces to a chestnut tree standing on the roadside at the top of the hill, also north 35 degrees, west 200 paces to Everett's barn. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 98, OR MILESTONE No. "XLI."

This monument is situated in an open field on the west slope of a small knoll near the foot on land of Aliakin Everett, and is distant 5,280 feet west of milestone "XL." At the monument the following bearings were taken: North 45 degrees, east about 200 paces to the southeast corner of Everett's barn and south 5 degrees, east 115 paces to a chestnut tree mentioned in the preceding description. Soil sandy. Disc set in sand and monument in cement. This monument projects only 3 inches above the ground, northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 99, OR ROAD No. 1 BETWEEN MILESTONES NOS. "XLI" AND "XLII."

This monument is situated on the north side of a road which runs north 68 degrees, west, and south 68 degrees, east, and is distant about 418 feet west of milestone "XLI." At the monument the following bearings were taken: South 68 degrees, east 248 paces along the road to a white oak tree mentioned in No. 97, and south 30 degrees, east 240 paces to a chestnut mentioned in No. 97. Soil sandy. Disc set in wood ashes. This monument has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 100 OR ROAD No. 2.

This monument is situated on the east side of a road which runs north 25 degrees east and on the westerly slope of the hill, and is distant about 2,906 feet west of milestone "XLI." At the monument the following bearings were taken: South 30 degrees, west 14 paces to the southwest corner of R. E. Hallock's barn, and north 40 degrees, east 7 paces to a cherry tree standing inside of a fence east of the road. Soil sandy. Disc set in wood ashes. This monument has its southeast corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 101 OR ROAD No. 3.

This monument is situated on the west side of a road which runs north 10 degrees east and south 10 degrees west, and is at the east foot of a hill and just opposite or in the line with the line fence between the lands of S. W. Benjamin and Charles Goldsmith, and is distant about 4,624 feet west of milestone "XLI." At the monument the following bearings were taken: South 10 degrees west along the road to the northwest corner of Benjamin's house, and north 45 degrees, east 145 paces along the road to Goldsmith's barn, standing on the east side thereof. Soil sandy. Disc set in wood ashes. This monument leans slightly to the north, otherwise it was found to be in good condition.

MONUMENT No. 102 OR MILESTONE No. "XLII."

This monument is situated on the east slope of a hill, about 20 paces from the top on south side of line fence and at junction of fence running northerly between the lands of Benjamin and Goldsmith, and 5,261.95 feet west of milestone "XLI." At the monument the following bearings were taken: South 35 degrees, east about 300 paces to the northwest corner of Benjamin's house and south 25 degrees, west 27 paces to a maple tree, also about 3 feet east to a live oak tree. Soil sandy, mixed with considerable slate. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 103 OR ROAD No. 1, BETWEEN MILESTONES "XLII" AND XLIII."

This monument is situated at the west foot of a steep slope and on the west side of a road which runs north 50 degrees east and south 50 degrees west and opposite a line fence, and is distant about 1,250 feet west of milestone "XLII." At the monument the following bearings were taken: South 23 degrees, east 10 paces to an oak tree which stands very near a prominent ridge of rocks and north 30 degrees, east about 250 paces to the southeast corner of David P. Clark's house, also south 51 degrees, east 9 paces to a large crow-foot cut in the ledge of rock. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 104 OR MILESTONE No. "XLIII."

This monument is situated in a line fence between lands of Widow Clark and Hack in low meadow ground, and is distant 5,270 feet west of milestone "XLII." At the monument the following bearings were taken: North 32 degrees, west 57 paces to a sugar maple tree and north 15 degrees, west 422 paces to a little red house standing just east of the road and on the land of Clark. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition. It was rather difficult to find this monument standing as it does a trifle south of the center of a stone fence on line between lands of Clark and Hack.

MILESTONE No. 105 OR ROAD No. 1 BETWEEN MILESTONES "XLIII" AND "XLIV."

This monument is situated on the west side of a road which runs north 30 degrees east and south 30 degrees west, and is is on the east slope of a small hill about 25 paces from the top, and is distant about 1,014 feet west of milestone "XLIII." At the monument the following bearings were taken: North 38 degrees, east 230 paces to the house mentioned in the preceding description, and south 51 degrees, east 9 paces to a live oak tree which stands just on the east edge of a road, and is the corner between the townships of Greenville and Minnesink; also about 6 feet north of the corner of a line fence between the lands of Clark

and Mr. Whorry. Soil sandy and very light. Disc set in wood ashes. This monument has its northwest corner broken, otherwise it was found to be in good condition.

MONUMENT No. 106 OR ROAD No. 2.

This monument is situated on the west side of a road which runs about north and south, on ground sloping gently westward, and is distant about 3,685.9 feet west of milestone "XLIII." At the monument the following bearings were taken: South 51 degrees, east to a corner of a line fence between land of Northrup and Clark, and north 55 degrees, west 300 paces to the northeast corner of Chris. Forgersen's house, which stands just south of a lane which leaves the main road 150 paces north of the monument; also north 47 degrees, east 60 paces to a white oak tree standing by the roadside. Soil very rocky towards the bottom. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 107 OR MILESTONE No. "XLIV."

This monument is situated in a kind of low swampy meadow on the north edge of a lane which runs by Forgersen's house, about 20 feet east of the edge of the upland and 45 paces west of a small stream, 5,304 feet west of milestone "XLIII." At the monument the following bearings were taken: South 51 degrees, east 5 paces to a live oak tree, and north 51 degrees, west to a live chestnut tree. Soil clay with some gravel. Disc set in wood ashes. This monument projects 12 inches above ground, otherwise it was found to be in good condition.

MONUMENT No. 108 OR ROAD No. 1 BETWEEN MILESTONES "XLIV" AND "XLV."

This monument is situated on the east side of a road which runs north 65 degrees east and south 65 degrees west, and on ground sloping gently eastward, and is distant about 2,965 feet west of milestone "XLIV." At the monument the following bearings were taken: South 58 degrees, east 140 paces to a large maple tree standing on the east bank of a brook, and about 2 paces to the

corner of a line fence between the lands of John Taylor and the Widow Corwin; also south 58 degrees, west 190 paces to the northwest corner of the Widow Corwin's house. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 109 OR MILESTONE No. "XLV."

This monument is situated in the northeast corner of a meadow belonging to Albert Corwin, at the southwest corner of the woods, 3 paces westerly of worm fence running southerly, and is distant 5,301 feet west of milestone "XLIV." At the monument the following bearings were taken: North 55 degrees, west 450 paces to the northeast corner of Corwin's house, which stands on the west side of the road running along the east foot of Blue Mountain, and north 44 degrees, east 9 paces to a hickory tree. Soil clayey. Disc set in wood ashes. This monument projects 15 inches above the ground, otherwise it was found to be in good condition.

MONUMENT No. 110 OR ROAD No. 1 BETWEEN MILESTONES "XLV" AND "XLVI."

This monument is situated on the east side of a road which runs north 25 degrees east and south 25 degrees west along the east foot of the Blue mountains, and is distant 47 feet south of the corner of a line fence between the lands of Lansing Simpson and Albert Conover. At the monument the following bearings were taken: South 55 degrees, west 34 paces to the northeast corner of the Widow Taylor's house, and north 25 degrees, east 200 paces to the southeast corner of Simpson's house. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 111 OR MILESTONE No. "XLVI."

This monument is situated in low scrub oaks on the west slope of the east summit of the Blue mountains, about 200 paces from the summit, and 210 paces west of an old wood road running north and south. At the monument the following bearings were taken:

North 50 degrees, west 75 paces to a gum tree standing in the first hollow west of the summit, south 50 degrees, west to another tree, north 50 degrees, west 7 paces to a smaller pine tree, and north 50 paces to a hickory tree standing alone. Soil sandy. The monument having been broken in getting it to the place, was only set in about 1½ feet, but was very firmly wedged. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 112 OR MILESTONE No. "XLVII."

This monument is situated on the west slope of the Blue Mountains in a low thick brush, but on ground that has once been cultivated, and is distant 5,280 feet west of milestone "XLVI" and about 5 paces west of the edge of a wood road bearing south 65 degrees west. At the monument the following bearings were taken: South 25 degrees, west 29 paces to a chestnut tree which stands at the angle in the road and just on the north edge of a large growth of trees, also north 40 degrees, west about one-third of a mile to James Hamilton's house, which stands in Fiddler's Elbow. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 113 OR ROAD No. 1, BETWEEN MILESTONES "XLVII" AND "XLVIII."

This monument is situated on the east side of a road which runs a little northeast and southwest and at the foot of Hogback mountain, and is distant about 10,000 feet west of milestone "XLVI." At the monument the following bearings were taken: North 50 degrees west, to the south end of Alex. Burrow's house or saloon, which stands about 3 feet clear in New York, the line at this point passing between his house and saloon, also 3 feet south of the corner of a line fence between lands of Michael Fitzgerald and M. D. Graham. Soil sandy. Disc set in wood ashes. This monument has its top flush with the surface of the ground, otherwise it was found to be in good condition.

MONUMENT No. 114 OR MILESTONE No. "XLVIII."

This monument is situated on the top of the Hogback mountain on the south side of a line fence between lands of Thomas Dutton

and the Widow Snyder, and is distant 10,419 feet west of milestone "XLVI," 40 feet east of a ridge of rock and 40 paces west of a small oak tree, about 5 inches in diameter, which stands in said line fence. At the monument the following bearing was taken: North 65 degrees, east to a hemlock tree. No disc used. This monument has its northeasterly corner slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 115 OR ROAD No. 1, BETWEEN MILESTONE "XLVIII" AND CARPENTER'S POINT.

This monument is situated on the west side of a road which runs north 25 degrees east, and south 25 degrees west, on ground sloping gently eastward, and is distant about 300 paces west of milestone "XLVIII," in thick berry bushes. At the monument the following bearings were taken: South 64 degrees, west 125 paces to a hemlock tree standing on the top of the hill, and north 10 degrees, west 175 paces to the southeast corner of the Widow Snyder's house, also north 50 degrees, west to an old foundation. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

MONUMENT No. 116 OR NEVERSINK RIVER MONUMENT.

This monument is situated about 15 paces east of the water edge of the Neversink river and on land of Mr. Phillips. At the monument the following bearing was taken: South 50 degrees, east 135 paces to an old foundation standing south of the Widow Snyder's house. Soil sandy. Disc set in wood ashes. This monument was found to be in good condition.

WESTERN WITNESS OR REFERENCE MONUMENT.

This monument stands on an eminence about midway between the rivers Delaware and Neversink and on land of the Laurel Grove Cemetery Company, and is distant north 64 degrees, east 72½ feet from the tri-States rock or monument. It is similar in form and dimensions (above ground) to the witness or reference monument at the eastern terminus of the line, and in addition to the inscriptions cut on that monument, it is further marked on

27

one of its edges with the words "Witness Monument" and on the north side with the words "The corner between New York and Pennsylvania is in the center of the Delaware river, 475 feet due west of the tri-State rock" and on the New Jersey side with the words "South 64 degrees, west 72½ feet from this is the tri-State rock, which is the northwest end of the New York and New Jersey boundary, and the north end of the New Jersey and Pennsylvania boundary." This monument was found to be in good condition.

TRI-STATE MONUMENT.

The point which this monument is intended to define was originally indicated by a crow foot cut in the natural limestone rock and which in 1874 was very plain, although its cut edges were somewhat smoothed by the exposure of 100 years. In 1874 the United States Coast and Geodetic Survey, at the request of the Geological Survey of New Jersey, determined accurately the latitude and longitude of this point, and at the close of the work marked it by drilling a deep hole in the rock and fastening in it a copper tube filled with lead, and setting and describing proper witnesses of its location. The station point according to this determination is in latitude 41 degrees 21 minutes 22.63 seconds north; longitude 74 degrees 41 minutes 40.70 seconds west from Greenwich.

By order of the joint commission on boundary line between the States of New York and New Jersey the copper bolt was excavated October 30, 1882, in making foundation for the existing granite monument, the center of which was placed directly over the point occupied by the bolt. The monument as originally set in 1882 was similar in form and dimensions and built into the solid rock in the same manner as the witness or reference monument at the eastern terminus of this line. In the spring of 1883 the upper portion was broken off by ice, and on May 21, 1885, by order of Commissioner Leavenworth, of New York, and Commissioner Cook, of New Jersey, the remaining portion was redressed to the existing dimensions, which are as follows: Two feet 4 inches long, 1 foot 4 inches wide, and 1 foot 5 inches high above the surface of the

rock in which it is embedded. Upon its top surface it was marked with one-quarter inch groove showing the direction of the lines of the three States which meet there, and within the surface bounded by the lines the initials of the respective States are cut. The north side of the stone is further marked with the words "Tri-State Monument." This monument is built into the natural rock at the junction of and near the high water mark of the rivers Delaware and Neversink, and at this date is in good condition as above described.

NOTE.

The discs referred to in the above description are of earthen ware, 6 inches in diameter, 1 inch thick, and perforated in the center, and are, unless otherwise stated, placed vertically beneath the point to be marked by the monument, and 6 inches beneath its bottom.

Report on the Examination of Monuments Marking the Boundary Line Between the States of New York and Connecticut.

ALBANY, N. Y., *December* 29, 1896.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.— In pursuance of your instructions I have made an examination of the monuments marking the boundary line between the States of New York and Connecticut, and have the honor to submit this my report.

The determination of this line was the cause of controversies which extended over two centuries. They had their origin in the early settlement by emigrants from Connecticut of the territory along Long Island sound, which was then claimed and held by New York. At this time there was no distinct line established between the provinces, and as the emigrants would not fraternize with the Dutch settlers of New York, an effort was made in 1664 to have this line defined and located. For this purpose commissioners were appointed on the part of the Duke of York and delegates on the part of the colony of Connecticut. An agreement was reached between them, but so little was known of the situation of the country in the interior that after a short time it was found impossible to carry into effect the articles of agreement, and they were, by mutual consent, dissolved.

As the settlers increased and the country developed, questions of jurisdiction arose so frequently that, in 1683, a new agreement was reached, which stipulated that a tract on Long Island sound, which was described as containing 61,440 acres, should be permanently set off to Connecticut by New York, on condition that the former should in exchange set off to New York a tract of like extent, to be of equal width, from the tract on the sound to the south line of Massachusetts.

This agreement was sanctioned by royal ordinance, and in 1684 was carried into effect by New York, at least, when the tract on the sound was surveyed and set off to the full possession of Connecticut.

A contract to make an exchange of an equal number of acres of land was certainly not one of apparent difficulty in execution, and would not have been so had both parties to the agreement been desirous of abiding by its terms. Connecticut had secured and was in full possession of the tract due her; in return, under various absurd pretexts, she refused to carry out her part of the contract, withholding from New York, for forty-eight years, the equivalent tract due her, and then only yielding when compelled by a royal decree.

The line, as then established, seemed to be satisfactory to all concerned, for no disputes arose concerning it until subsequent to 1850, when trees, which had been marked, had all disappeared, some of the monuments been moved, and, owing to the changes among the people, few of them knew of the monuments remaining, that questions of jurisdiction were raised, and controversies began regarding the position of the line. Doubt, which none had authority to solve, rendered the situation more and more serious, so that in May, 1855, Connecticut made the proposition that the true position of the line be found, by having a new survey made of it, and that it then be monumented. This proposition was accepted by New York, and in the following year a commission was appointed by New York to act in connection with a like commission appointed by Connecticut, to ascertain and mark with suitable monuments the original line. Although the powers of the commission were expressly limited to the ascertaining and marking of the line, as determined by the survey of 1731, the commissioners from Connecticut persistently refused to be bound by any such limitation, and proposed that a new line be run northerly from the Ridgefield angle to the south line of Massachusetts. All efforts having been made to induce Connecticut to withdraw from such a stand without success, New York State, by act of April 3, 1860, authorized her commissioners to proceed alone, if necessary, in the

ascertaining and marking of this line. This was done that year, and for the first time after two centuries of wrangling the line was properly and permanently monumented. In 1878 Connecticut accepted this line as established, but the whole expense incurred in its establishment was borne by New York.

The monuments marking the line are, for the most part, of cut stone; the remainder of them are iron bolts fixed in the rocks; these latter are located in almost inaccessible places and where it was impossible to bring stone monuments.

Considering that no repairs have ever been made on this line its condition and the condition of the monuments marking it is as good as might be expected. One of the monuments is missing; one has been broken off close to the ground; three have been moved; one lacks an inscription to identify it, and seven others need to be reset. The distance between many of the monuments is excessive; to render them effective there should be none more than a mile apart, and I would suggest that if co-operation can be secured with Connecticut, with the other repairs needed, mile-posts be established for the full length of the line.

The monuments from the Massachusetts line to and including the tenth-mile monument and the five and two-mile points on the line from Duke's trees to the stone at the wading place, are of sawed marble, eight inches square, from five to six feet in length, and standing out of the ground two and a half feet. The monument from the tenth-mile to Wilton angle, and including one west of said angle, also those at the twelfth and fifth-mile points, on the line, parallel to the sound, are of cut granite, finished two and a half feet, eight inches square at the base or surface of the ground and six inches square at the top; the remainder being of rough granite slabs about six by twelve inches, and projecting eighteen inches above the ground; and in several locations iron bolts are used. The monuments marking the original mile points are marked with the number of the mile corresponding to the original survey, and all others are marked with the initials of the State on the proper sides.

CHARLES H. FLANIGAN.

Detailed Description of the Location of the Monuments on the New York and Connecticut Boundary Line.

MONUMENT No. 1.

The junction of the New York and Connecticut line with the south line of Massachusetts is marked by a marble monument standing in thick young woods between the two westermost hills of the Taghcanic mountains. It is on the line between the property of the Millerton Iron Company and Frederick Niles. This monument has its northwest edge chipped, otherwise it was found to be in good condition.

MONUMENT No. 2.

Distant 58.25 chains from monument No. 1. Is an iron bolt placed in a rock on the east brow of a high ridge and surrounded by a heap of stones. This monument could not be found.

MONUMENT No. 3.

Distant 160.74 chains from monument No. 1. Is an iron bolt fixed in a rock westerly from the southerly end of North pond, and 15.59 chains northerly from where the line crosses the outlet of Grass pond. This monument could not be found.

MONUMENT No. 4.

Distant 244 chains from monument No. 1. Is an iron bolt in a large rock on a high rocky ridge on the northerly side of a run or deep ravine, and about 250 feet westerly of an old wood road leading from Long pond to Riga station. There is a large pile of stones on the northerly side of this monument. It projects out of the rock 2½ inches. It is on the property of the Millerton Iron Co. This monument was found to be in good condition.

MONUMENT No. 5.

Distant 306.21 chains from monument No. 1. Is an iron bolt in a rocky ridge at the brow of West mountain, at the top of a westerly slope, east of Riga station, and about a half mile easterly of pasture land and a run. It projects 3 inches out of the rock. It is on the line between the properties of the Millerton Iron Co. and James Campbell and Edward Hanlen. This monument was found to be in good condition.

MONUMENT No. 6 — 47-MILE MONUMENT.

Distant 464.69 chains from monument No. 1. On level ground at the west end of a worm fence and south end of stone fence, and about 470 feet south of Bird Hill highway. It is on line between the property of John McGinnis and the Poughkeepsie Bridge Railroad Company, and James Campbell and Edward Hanley. This monument leans about 6 inches to the south, otherwise it was found to be in good condition.

MONUMENT No. 7.

Distant 41.06 chains from monument No. 6. At the junction of road leading from Millerton to Lakeville, with the road from Spencers Corners, just north of State Line depot, and about 150 feet west of the residence of John McGinnis. It is on line between the property of John McGinnis and the Poughkeepsie Bridge Railroad Company. This monument has its corners and edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 8.

Distant 129.09 chains from monument No. 6. On the east side of a road leading from Millerton to Ore Hill, alongside worm fence, in thick brush. It is on the line between the property of Thomas Diamond and Ambrose Culver. This monument has its edges badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 9 — 44-MILE MONUMENT.

Distant 239.57 chains from monument No. 6. It is just south of a barb wire fence standing on the south side of a highway running along the north side of Indian pond. From the monument

easterly 9 feet is a small maple tree, and westerly 36 feet is an 18-inch pine. It is on the property of the Hiram Clarke estate. This monument leans slightly, and has three of its corners badly broken.

MONUMENT No. 10.

Distant 85.19 chains from monument No. 9. On the north side of a road leading from Millerton to Sharon valley, and about 100 feet west of the residence of Charles Daken. It is on the line between the property of Charles Daken and the Hazard sisters. This monument was found to be in good condition.

MONUMENT No. 11 — 42-MILE MONUMENT.

Distant 160.99 chains from monument No. 9. On the brow of the bank on the north side of Ten-Mile river, where the river runs easterly at the south end of line fence, and 5.29 chains on a perpendicular line easterly from the east side of Ten Mile river. This monument was found to be in good condition.

MONUMENT No. 12.

Distant 15.63 chains from monument No. 11. On the north side of a highway leading from Sharon station, on the Harlem railroad, to Sharon valley, and about 6 feet south of the south end of a line fence. It is on the property of W. P. Day. This monument leans badly, and has its south edge badly chipped.

MONUMENT No. 13.

Distant 137.47 chains from monument No. 11. On the south side of a road leading from Amenia to Sharon through Sharon valley and opposite the residence of H. S. Moorhouse. It is on the property of H. S. Moorhouse. This monument was found to be in good condition.

MONUMENT No. 14 — 40-MILE MONUMENT.

In a wet piece of ground about 40 rods east from Ten-Mile river and 167 feet on a south 43-degree east course from a well on the east side of a house occupied by Mrs. Robert E. Randall. It is on the property of Mrs. Robert E. Randall. This monument was found to be in good condition in every respect.

MONUMENT No. 15.

Distant 29.54 chains from monument No. 14. On the north side of the Beecher Hill road, which leads from Leedsville to Ellsworth, on a westerly slope, about 200 feet west of the brow of the hill and 7 feet west of line fence. It is on the property of Myron B. Benton. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 16.

Distant 217.21 chains from monument No. 14. On the north end of road that runs nearly north and south through the village of Amenia Union, 55 feet easterly from the northeast corner of the residence of Mrs. Harrison. This monument has its corners and edges badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 17.

Distant 229.81 chains from monument No. 14. On the south side of a road leading southeasterly from Hitchcocks Corners or Amenia Union. It is alongside of a picket fence, 167 feet easterly from the southeast corner of Nathaniel Smith's residence. It is on the property of Nathaniel Smith. This monument leans slightly to the west, otherwise it was found to be in good condition.

MONUMENT No. 18.

Distant 347.42 chains from monument No. 14. On the south side of the road leading over Clark's hill, just east of where the road turns sharply to the north, and about 500 feet south of the residence of Oliver Wheeler. It is on the property of Oliver Wheeler. This monument has been broken off close to the ground.

MONUMENT No. 19 — 35-MILE MONUMENT.

Distant 398.21 chains from monument No. 14. About 100 feet from the foot of Pinacle mountain, on a steep northwesterly slope, in young woods, among boulders, and about 100 feet west of large boulder which stands on the west side of a narrow path. It marks the corner of the towns of Kent and Sharon, in Connecticut, and is 3 feet south of the center of a rock upon which is placed the

original monument of 1731. It is on the property of Frank Barlow. This monument was found to be in good condition in every respect.

MONUMENT No. 20 — 33-MILE MONUMENT.

Distant 158.96 chains from monument No. 19. On the west side of Chase's mountain, in thick woods at the foot of steep northwesterly slope, on the north side of a hollow rock on which was erected the original monument, and about half a mile southeasterly of the residence of Henry Cribly. It is on the property of Matt Darling. This monument was found to be in good condition in every respect.

MONUMENT No. 21.

Distant 51.57 chains from monument No. 20. On the north side of a road leading from South Amenia to Kent, about 300 feet east of the residence (small frame) of Widow Winegar. It is on the line between the property of Milo Bolt and the Winegar estate. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 22.

Distant 111.87 chains from monument No. 20. An iron bolt on the southeast brow of a high ridge in the Preston chain of mountains, north of the mountain road leading from Macedonia to Dover, about 150 feet south of the summit. It projects out of the rock 6 inches. It is on the line between the property of William H. Tanner and Levi W. Slone. This monument was found to be in good condition in every respect.

MONUMENT No. 23 — 30-MILE MONUMENT.

Distant 243.37 chains from No. 20. It is on the south side of a high hill, in young trees, on the east side of the Chappell lot clearing, 2 feet east of barb wire fence and 6.3 feet south of an iron bolt marking the original monument. It is on the line between the property of Edwin Vincent and George Tabor. This monument was found to be in good condition in every respect.

MONUMENT No. 24.

Distant 60.83 chains from monument No. 23. An iron bolt fastened in a rock near its southwest corner on the southeast slope of a rocky ridge. The rock has a slight southeasterly slope and is surrounded by a ten-year growth of scrub oak. The bolt projects out of the rock 4 inches. It is on the line between the property of Gilbert Tabor and the Kent Iron Company. This monument was found to be in good condition in every respect.

MONUMENT No. 25—28-MILE MONUMENT.

Distant 161.32 chains from monument No. 23. It is on the slight southeast slope of the Schaghticoke mountain in thick, young woods, 8 feet north of an 18-inch chestnut, which stands just to the east of the line. It is on the line between the property of the Kent Furnace Co. and the Indian reservation. This monument has its corners slightly chipped, otherwise it was found to be in good condition.

MONUMENT No. 26.

Distant ——— chains from monument No. 25. It is on the east side of a road which runs southerly from the foot of Schaghticoke mountain crossing Ten-Mile river, at the north end of Ten-Mile hill and where road turns sharply to the west. It is 231.5 feet north of the east window of the house now occupied by the Thorpe family, through which window the line passes. It is on the line between the property of Cleveland Titus and Ebenezer Preston. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 27—26-MILE MONUMENT.

Distant 160 chains from monument No. 25. On the northwest slope of Ten-Mile hill in a cleared field surrounded by woods 12 feet east of a stone line fence. It is on the property of Charles Gardiner. This monument was found to be in good condition.

MONUMENT No. 28.

Distant 91 chains from monument No. 27. On the south side of a road leading from South Dover to Gaylords Bridge, and just

north of dwelling of John Gray. It is on line between the property of Frank Gay and the Geddings estate. This monument was found to be in good condition in every respect.

MONUMENT No. 29.

Distant 111.15 chains from monument No. 27. On the south side of a road leading from South Dover to Sherman Center, about at the foot of a westerly slope, and 400 feet southwest of the frame house of Christopher Madison. It is on line between the property of Frank Gay and the Geddings estate. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 30.

Distant 244.59 chains from monument No. 27. On the north side of a road leading from Quaker Hill to Sherman Center, east of the dwelling of James Osborne and about 100 feet east of a bridge crossing small stream. It is on the line between the property of Uriah Snedecker and Thomas McGorick. This monument was found to be in good condition in every respect.

MONUMENT No. 31 — 22-MILE MONUMENT.

Distant 320.11 chains from monument No. 27. On the summit of Sherman Hills, about a quarter of a mile south of the south end of stone line fence and 120 feet south of ravine which crosses the line to the southeast. The timber on the New York side of the line has been cut off and the land is now grown up to bushes. It is on line between the property of Jackson Hubbel and Uriah Snedecker. This monument has its southeast corner broken, otherwise it was found to be in good condition.

MONUMENT No. 32.

Distant 119.43 chains from monument No. 31. On an old road now a lane, which runs northerly from the dwelling on the estate of Egbert Haviland, 12 feet east of line fence and on south side of stone fence running northeasterly. It is on the property of Egbert Haviland. This monument was found to be in good condition in every respect.

MONUMENT No. 33 — 20-MILE MONUMENT.

Distant 163.17 chains from monument No. 31. At the north end of a meadow 25 feet west of thick woods, and 15 feet east of fence on the east side of the road, and 200 feet north of road running from Sherman to Quaker Hill. It is on the property of Anan J. Briggs. This monument was found to be in good condition in every respect.

MONUMENT No. 34.

Distant 83.16 chains from monument No. 33. On the summit between monuments Nos. 33 and 35 and about a quarter of a mile north of the Wakeman sisters house, and 70 feet east of a brush fence. It is on the property of Mrs. Bancroft. This monument was found to be in good condition in every respect.

MONUMENT No. 35 — 18-MILE MONUMENT.

Distant 159.09 chains from monument No. 33. On the brow of a rocky ledge, north of a ravine, through which flows a stream of water and on the west side of brush fence in thick young woods. It is on the property of Daniel Jennings. This monument was found to be in good condition in every respect.

MONUMENT No. 36.

Distant 37.87 chains from monument No. 35. On the south side of a highway called the "Old Turnpike" leading from Pauling to New Milford, where it crosses a swamp and to the west of a low rocky ridge. It is on the property of Daniel Jennings. This monument had fallen over and was reset upright by men working the road.

MONUMENT No. 37.

Distant 106.30 chains from monument No. 35. On the north side of the highway leading from Quaker Ridge to Haviland Hollow, on the first road north of Cranberry mountain and alongside stone fence. It is on the property of John Worden. This monument was found to be in good condition in every respect.

MONUMENT No. 38 — 16-MILE MONUMENT.

Distant 157.15 chains from monument No. 35. On the summit of Cranberry mountain, on a level spot in thick young woods 30 feet east of a boulder 4 feet high and northwest of two shallow pond holes, the nearest of which is 90 feet from the monument. It is also about due west of the residence of H. B. Wanser. It is on the property of H. B. Wanser. This monument has its top and sides chipped, otherwise it was found to be in good condition.

MONUMENT No. 39.

Distant 83.95 chains from monument No. 38. At the foot of a high ridge, on an easterly slope, in cleared field on the west bank of the east branch of Croton river, 121 feet north of highway bridge crossing said river. It is on the property of Harrison Wood. This monument leans slightly to the east, otherwise it was found to be in good condition.

MONUMENT No. 40.

Distant 143.54 chains from monument No. 38. On the south side of a road leading southeasterly from Haviland Hollow. It is on the property of Daniel Gerow. This monument leans slightly to the north, otherwise it was found to be in good condition.

MONUMENT No. 41 — 14-MILE MONUMENT.

Distant 161.07 chains from monument No. 38. On the northwest slope of a hill in the woods, about 250 feet east of line fence. It is on the property of Daniel Gerow. This monument has its northwest corner chipped, otherwise it was found to be in good condition.

MONUMENT No. 42.

Distant 74.40 chains from monument No. 41. On the north side of a road leading westerly from Ball's pond, near the top of a steep southeasterly slope. It is on the property of Egbert Haviland. This monument was found to be in good condition in every respect.

MONUMENT No. 43.

Distant 176.69 chains from monument No. 41. On the north side of a road leading from Delos Barnum's residence to the south end

of Ball's pond, and about 250 feet east of the small white dwelling-house of Oscar P. Turner. It is on the property of Leonard Carey. This monument has its edges badly chipped, otherwise it was found to be in good condition.

MONUMENT No. 44.

Distant 256.89 chains from monument No. 41. On the north side of a road leading from Milltown to Ball's pond, 85 feet east from the east side of a road running nearly north and south and about 200 feet northeasterly from the residence of Mrs. Benjamin Teale. It is on the property of Alfred Barnum. This monument was found to be in good condition in every respect.

MONUMENT No. 45 — 10-MILE MONUMENT.

Distant 313.41 chains from monument No. 41. In a meadow 300 feet easterly of the dwelling of Adelbert Salmons, 155 feet north of low rocky ridge on line and 300 feet south of highway. It is on the property of Oran Salmons. This monument was found to be in good condition in every respect.

MONUMENT No. 46.

Distant 59.36 chains from monument No. 45. On Round mountain on an easterly slope, 70 feet east of the summit in young woods. It is on the property of George Horton. This monument was found to be in good condition in every respect.

MONUMENT No. 47.

Distant 140.42 chains from monument No. 45. On the north side of a highway leading from Milltown to Danbury, about 600 feet easterly of the residence of David Hall. It is on the property of David Hall. This monument was found to be in good condition in every respect.

MONUMENT No. 48 — 8-MILE MONUMENT.

Distant 155.71 chains from monument No. 45. In a small hollow on the east end of Joe's hill, in thick young woods, 2 feet west of worm line fence. It is on the property of David Hall. This monument was found to be in good condition in every respect.

MONUMENT No. 49.

Distant 67.95 chains from monument No. 48. On the south side of the turnpike leading from Milltown to Brewster Station, at its junction with lane running to the north and about 150 feet southwesterly of the residence of William Fields. It is on line between the property of William Fields and Samuel Evans. This monument was found to be in good condition in every respect.

MONUMENT No. 50 — 6-MILE MONUMENT.

Distant 159.28 chains from monument No. 48. In a wet stony meadow on the north side of a swamp, about 200 feet south of an old road, which is now but little used, and 30 feet west of stone fence running north and south. It is on the property of Oscar Nichols. This monument leans badly to the south and has heaved 6 inches.

MONUMENT No. 51.

Distant 119.54 chains from monument No. 50. On the west side of a road leading from Peach pond to Ridgebury, at the southerly end of the road, where it runs nearly north and south, and thence easterly and opposite an old frame house, and about 250 feet west of the residence of Edward Cunningham. It is on the property of Joseph Vail. This monument was found to be in good condition in every respect.

MONUMENT No. 52 — 4-MILE MONUMENT.

Distant 164.42 chains from monument No. 50. It is near the north end of a boggy meadow, 15 feet west of stone fence running north and south and about 20½ rods easterly of Mopus brook. It is on the property of Mrs. John Smith. This monument leans slightly to the north, otherwise it was found to be in good condition.

MONUMENT No. 53.

Distant 51.62 chains from monument No. 52. It is on the south side of the road leading from North Salem to Ridgebury, about 700 feet west of the residence of Thomas Mead and 60 feet east of line fence. It is on the line between the property of Spencer Mead and Henry Norton. This monument has its corners chipped, otherwise it was found to be in good condition.

MONUMENT No. 54.

Distant 81.19 chains from monument No. 52. On the south side of a road leading from North Salem to Ridgefield, about 400 feet east of the residence of Rev. Thomas Lathrop, and 12 feet west of 15-inch locust tree. It is on the property of John Hunt. This monument leans badly to the west and should be reset.

MONUMENT No. 55 — 2-MILE MONUMENT.

Distant 158.99 chains from monument No. 52. In thick woods on southwesterly slope, about 50 feet west of a precipitous rocky ledge and near the foot of the slope of Sarah Bishop mountain, about 600 feet south of the rail fence at the edge of the clearing. It is on the property of Jesse Lockwood. This monment was found to be in good condition in every respect.

MONUMENT No. 56.

Distant 72.04 chains from monument No. 55. On the south side of Sarah Bishop mountain, in a meadow known as the "Monument lot," 1,000 feet westerly of the residence of Theodore Mead. It is on the property of Theodore Mead. This monument was found to be in good condition in every respect.

MONUMENT No. 57 — THE RIDGEFIELD ANGLE.

Distant 109.41 chains from monument No. 55. On the steep northerly slope of a hill which lies southeast of Lake Waccabuc, 40 feet east of a stone fence, about 680 feet southerly from where the line crosses a small brook. It is on the property of James Pardee. This monument was found to be in good condition.

MONUMENT No. 58.

Distant 15.64 chains from monument No. 57. On the north side of a road leading from Ridgefield to the west end of Lake Waccabuc, alongside of stone fence and about 125 feet easterly of the residence of James Pardee. It is on the property of James Pardee. This monument was found to be in good condition in every respect.

MONUMENT No. 59.

Distant 80.88 chains from monument No. 57. On the north side of the highway running nearly east and west from Ridgefield to South Salem, along the north side of low swampy ground and in front of frame house occupied by Walter Toles. It is on the property of Harry Sheldon. This monument was found to be in good condition in every respect.

MONUMENT No. 60.

Distant 119.15 chains from monument No. 57. On the south side of the old turnpike, known as "The New York and Hartford Turnpike," about 150 feet easterly of the residence of George O'Brien. It is on the property of Fleming Tyler. This monument leans to the north and has heaved six inches, otherwise it was found to be in good condition.

MONUMENT No. 61 — 4-MILE MONUMENT.

Distant 213.39 chains from monument No. 57. In low wet meadow, 58 feet north of a brook running through said meadow into a millpond. It is on the property of Eldridge Northrup. This monument was found to be in good condition in every respect.

MONUMENT No. 62.

Distant 46.45 chains from monument No. 61. On the south side of a road leading from Lewisboro to Ridgefield, nearly opposite the residence of Frank Staple. It is on the property of M. B. Carey. This monument leans badly to the north, otherwise it was found to be in good condition.

MONUMENT No. 63 — 2-MILE MONUMENT.

Distant 157.63 chains from monument No. 61. In the woods on the west side of a ridge four feet south of the center of the old monument,piled upon the top of a rock sticking out of the ground. This monument marks the corner of the towns of Ridgefield and Wilton in Connecticut. It is on the line between the property of Rufus Roscoe and Charles Raymond. This monument was found to be in good condition in every respect.

MONUMENT No. 64.

Distant 92.72 chains from monument No. 63. On the west side of a road which runs nearly north and south, on the south slope of a hill, and about a quarter of a mile east of the residence of Rufus Roscoe. It is on the property of Rufus Roscoe. This monument was found to be in good condition in every respect.

MONUMENT No. 65 — THE WILTON ANGLE.

Distant 167.28 chains from monument No. 63. On level land in woods west of Ball hill and south of Bear swamp, and is in the center of a heap of stones erected by the commission of 1731, and five feet east of a three-foot birch tree. It is on the property of John Kaiser. This monument was found to be in good condition in every respect.

MONUMENT No. 66.

Distant 26.89 chains from monument No. 65. On the east side of a road running from New Canaan to Vista, nearly opposite the residence of John Kaiser. It is on the property of John Kaiser. This monument has its edges chipped, otherwise it was found to be in good condition.

MONUMENT No. 67.

Distance not given. On the east side of the road running through the village of Vista and at the easterly end of the road, which follows the boundary line for a short distance. It is on the property of Samuel Comstock. This monument was found to be in good condition in every respect.

MONUMENT No. 68.

Distance 143.66 chains from monument No. 65. On the north side of a road running westerly from monument No. 67 to No. 69, near the top of a rather steep westerly slope. It is at the south-west corner of the "Equivalent Tract," and marks the corner of the towns of Lewisboro and Poundridge, N. Y. It is on the property of Samuel Comstock. This monument leans badly to the north, otherwise it was found to be in good condition.

MONUMENT No. 69.

Distance 11.33 chains from monument No. 68. On the west side of the road leading from Vista to Highridge and about 100 feet southerly from junction of road, which follows the boundary line. It is on the property of Rufus Smith. This monument was found to be in good condition.

MONUMENT No. 70.

Distance 57.62 chains from monument No. 68. On the west side of the road, near the southeast side of Mud pond and 115 feet northerly from frame dwelling. It is on the property of the Stanford Water Company. This monument was found to be in good condition in every respect.

MONUMENT No. 71 — 12-MILE MONUMENT.

Distance 90.87 chains from No. 68. On the northeast side of a hill 120 feet east of a large boulder lying on top of hill and 5 feet west of line fence. It is on the line between the property of the Benjamin Weed estate and H. Jones. This monument was found to be in good condition in every respect.

MONUMENT No. 72.

Distance 25.74 chains from monument No. 71. On the east side of a highway about 125 feet southerly from the residence of Benjamin Weed, and 2 feet westerly of board fence, in front of his residence. It is on the property of the Weed estate. This monument was found to be in good condition in every respect.

MONUMENT No. 73.

Distance not given. On the south side of the road leading from Dantown to Vista, about 200 feet westerly of a small frame dwelling of Sillick Dann. It is on the property of the Davis estate. This monument has no mark cut on it to identify it as a boundary line stone. This monument was found to be in good condition.

MONUMENT No. 74.

Distance 103.25 chains from monument No. 71. On the west side of the highway leading through Dantown to Highridge, about 200

feet north of an old abandoned road running east and west and directly opposite small barn of Henry Bouton. It is on the property of William Mead. This monument was found to be in good condition in every respect.

MONUMENT No. 75.

Distance 166.03 chains from monument No. 71. On the west side of the highway leading from Highridge to Poundridge, about 300 feet south of the dwelling of Ebenezer Jones, and 5 feet south of an opening in stone fence. It is on the property of John Bayliss. This monument was found to be in good condition in every respect.

MONUMENT No. 76 — 9-MILE MONUMENT.

Distant 241.93 chains from monument No. 71. Is an iron bolt in a rock on the highest point of the west ridge of a very high rocky ridge, where the ridge slopes to the west, between Miry brook swamp and Poole swamp. It is also 40 feet from a large boulder on a 41 degree 30 minute west course. It projects out of the rock 6½ inches. It is on line between the property of George Wood and Hiram Curtis. This monument was found to be in good condition in every respect.

MONUMENT No. 77.

Distant 81.57 chains from monument No. 76. On the west side of the highway leading from the village of Longridge, northerly, to Bedford, on a southerly slope and about 120 feet north of the residence of William Tallman, and 20 feet south of stone fence leading to barn. It is on the property of the Scofield estate. This monument was found to be in good condition in every respect.

MONUMENT No. 78.

Distant 214.30 chains from monument No. 76. On the west side of the road running nearly north and south along the ridge between Banksville and Longridge, about 150 feet southwesterly of the residence of Dr. Danborne. It is on the property of William H. Dobley. This monument was found lying on the ground and should be reset.

MONUMENT No. 79.

Distant 260.62 chains from monument No. 76. On the north side of a highway running nearly parallel with the line through the village of Banksville, 20 feet west of where the highway turns sharply to the south, about 250 feet easterly of the residence of Eugene Finch, 50 feet to the east of a monument marking the corner of the towns of Greenwich and Stamford, in Connecticut. It is on the line between the property of Edward Burns and Eugene Finch. This monument was found to be in good condition in every respect.

MONUMENT No. 80.

Distant 287.88 chains from monument No. 76. On the south side of the road running parallel with the line through the village of Banksville and at its junction with road running north and south, near the house of Widow Close, and opposite the store of W. S. Finch. It is on line between the property of Widow Close and William S. Finch. This monument was found to be in good condition in every respect.

MONUMENT No. 81 — 5-MILE MONUMENT.

Distant 319.12 chains from monument No. 76. In a thick young wood, on the northwest slope of a hill, there being swampy ground about 350 feet to the north, and about 200 feet south of the south end of a stone line fence. It is on the property of James Burns. This monument was found to be in good condition in every respect.

MONUMENT No. 82.

Distant 69.77 chains from monument No. 81. On the west side of a road and 80 feet north of its junction with road from the west, in front of the residence of Samuel Thomas. It is on the line between the property of Dr. Taylor and David Rich. This monument was found to be in good condition in every respect.

MONUMENT No. 83.

Distant 108.75 chains from monument No. 81. It is on the east side of a road, at the foot of a northerly slope. There is a knoll to the east and a swamp to the west of the monument. It is on

the property of George Dickinson. This monument has its north corner broken, otherwise it was found to be in good condition.

MONUMENT No. 84.

Distant 148.10 chains from monument No. 81. On the north side of a highway, on level ground at the foot of a westerly slope, about 200 feet east of the residence of William H. Creemer, 3 feet south of fence, between two large locust trees. It is on the property of William Creemer. This monument has its north corners broken, otherwise it was found to be in good condition.

MONUMENT No. 85.

Distant 243.38 chains from monument No. 81. On the west side of a road leading from Bedford to Portchester, 200 feet north of its junction with another road, and four feet east of fence. It is on the property of Abram S. Hopkins. This monument was found to be in good condition in every respect.

MONUMENT No. 86 — THE DUKE'S TREE ANGLE.

Distant 398.41 chains from monument No. 81. A round stone 18 inches high and 3 feet thick, marked "G. R.," as described in the survey of 1731, it lies in the ground on the west side of the wagon track of King street. This stone has been removed 20 feet to the north, out of line and away from its proper position. It should be replaced below the level of the roadway. It is on the line between the property of Walter Law and Peter Biani.

MONUMENTS No. 87 AND 88.

Witness monuments to monument No. 86. Originally these were set on a south 66 degree 25 minute course, one easterly 30 feet from said monument and the other 10.7 feet westerly from said monument. As the position of monument No. 86 has been changed these monuments no longer bear the same relation to it.

MONUMENT No. 89.

Distant 92.30 chains from monument No. 86. In a cleared field 175 feet west of King street and on the south side of first stone fence south of John Fields barn, and 600 feet south of road, lead-

ing to North Greenwich. It is on the property of John Fields. This monument was found to be in good condition.

MONUMENT No. 90 — 5-MILE MONUMENT.

Distant 172.93 chains from monument No. 86. It is in a cleared field in line of wire fence, and 284 feet north of highway leading from Bedford to White Plains. It is on the property of Frank Storrs. This monument leans to the south, otherwise it was found to be in good condition.

MONUMENT No. 91.

Distant 4.29 chains from monument No. 90. It is on a westerly slope, on the north side of a highway leading from Bedford to White Plains, about 215 feet east of wire fence running northerly. It is on the property of Frank Storrs. This monument has its south corners broken, otherwise it was found to be in good condition.

MONUMENT No. 92.

Distant 88.12 chains from monument No. 90. On the previous examination this monument was reported as being on the west side of King street, at the south corner of its junction with a lane and projecting 1 foot above ground. It is now 182 feet north of the south corner of lane on the west side of King street, in the driveway leading into the barns attached to the farmhouse of John H. Schultz, and projects out of the ground 38 inches. It is on the property of John H. Schultz. This monument has evidently been removed.

MONUMENT No. 93.

Distant 144.66 chains from monument No. 90. On the east side of King street, about 125 feet southwest of Mark Mead's dwelling, 60 feet southeast of George Pierson's dwelling, and 2 feet west of fence. It is on the property of Mark Mead. This monument was found to be in good condition in every respect.

MONUMENT No. 94.

Distant 183.73 chains from monument No. 90. On the north side of a road leading to White Plains, about 150 feet east of King

street and 4 feet south of large elm tree. It is on the property of James McClenahan. This monument was found to be in good condition in every respect.

MONUMENT No. 95.

Distant 224.78 chains from monument No. 90. In the report of the last examination this monument was described as being on the east side of King street, in front of the site of the old William Anderson house. It is now lying on the west side of the road, about opposite the point it originally occupied. This monument should be reset in its proper place. It is on line between the property of William Smelling and James Pine.

MONUMENT No. 96.

Distant 14.27 chains from monument No. 95. On the east side of King street, 80 feet north of its intersection with Ridge street, 12 feet west of fence and about 150 feet northerly of Methodist church. It is on line between the property of Robert T. Merritt and Sullivan M. Pine. This monument was found to be in good condition in every respect.

MONUMENT No. 97.

Distant 53.29 chains from monument No. 95. On the east side of King street, close to stone wall, and about the point where the street leaves the line and bears westerly from it, and about 450 feet northerly from the residence of Abram Whiteman. It is on the line between the property of John Haight and William Ryan. This monument was found to be in good condition in every respect.

MONUMENT No. 98.

Distant 93.83 chains from monument No. 95. This monument originally stood on the northeast slope of a high ridge, lying westerly from the screw factory on the Byram river, on the property of William Ward, Jr. This stone was removed by Ward to make room for an addition to his residence, and can not now be found. About 300 feet north of Ward's residence, and 60 feet east of driveway leading thereto, on the south side of main highway, a granite monument 6 x 6, and projecting 15 inches out of ground, was found.

We were not able to ascertain who set this monument, and in the absence of an instrumental survey can not tell whether it is on the line. This should be determined.

MONUMENT No. 99 — THE GREAT STONE AT THE WADING PLACE.

Distant 173.07 chains from monument No. 95. This is a cropping of rock at the northeast end of the stone highway bridge, across Byram river, on the stage road leading northerly from Portchester. A copper bolt formerly stood on the highest point of this stone, but is now gone. The hole in which it stood can still be seen. The bolt should be replaced.

MONUMENT No. 100.

Distant 12.60 chains from monument No. 99. A large rock in the middle of Byram river; originally a copper bolt was fixed on its highest point, but is now gone. The hole in which the bolt stood is still plainly visible. The bolt should be replaced.

APPENDIX IV

EASTERN DIVISION

REPORT.

ALBANY, N. Y., *October* 1, 1896.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.— I have the honor to submit to you my annual report as division engineer, eastern division of the New York State canals for the fiscal year ending September 30, 1896.

The mileage of canals, feeders and river improvements on the eastern division is as follows:

NAVIGABLE.

	Miles.
Erie canal from Albany basin to east line of Oneida county	106.243
Port Schulyer and West Troy side-cuts	.350
Albany basin	.770
Champlain canal, including Waterford side-cut, Cohoes and Saratoga dams	66.000
Pond above Troy dam	3.000
Glens Falls feeder and pond	12.000
Total	188.363

FEEDERS NOT NAVIGABLE.

Mohawk river at Rexford's flats	.39
Mohawk river at Rocky rift	3.92
Mohawk river at Little Falls	.19
Schoharie creek	.63
Total	5.13

The traffic on the canals this season has shown a marked increase over the year previous. Navigation has been maintained with but few interruptions, the most serious of which was caused by a break in the towing-path bank near Rotterdam junction, between locks Nos. 24 and 25, on the night of July 23d. The break occurred during a heavy thunder storm in that vicinity which raised the water in the canal sufficiently to overflow the low embankment at that point, which soon washed an opening about seventy-five feet wide down to canal bottom. Work of repairing was immediately commenced, and navigation was resumed on the morning of the 26th; total delay, three days. Several serious leaks have occurred which were repaired before much damage was done; in most cases without drawing off the water. The condition of the canals are about as stated in my previous reports. The banks in many places are only a few inches above water surface. Where wooden docking is used it is old and decayed, and affords very little protection to the banks. A large portion of the vertical and slope walls needs relaying. The aqueducts (excepting the lower and upper Mohawks and Schoharie creek aqueducts) are in a more or less dilapidated condition. The same is true of the waste-weirs and several culverts. I will not refer to them in detail nor make any recommendations for repairs, except such temporary repairs and reinforcements as may be necessary to keep them from any further deterioration until they can be reached through the work of improving and deepening the canals, as authorized by chapter 79, Laws of 1895, plans for which have already been submitted to you. The plans involve some alterations in most of the structures to conform to the increased depth of prism, and also includes relaying walls and raising and strengthening the banks where required.

Some trouble was experienced during the early part of the month of July on account of low water, particularly between the Schoharie creek and Rexford flats feeders. The Schoharie creek dam leaks badly, so that during dry weather almost the entire flow of the stream passes through it. The canal, therefore, receives very little water between the Rexford flats and Rocky rift feeders, a distance of fifty miles. By careful management of the water, the delays to the boats were of short duration, and copious rains during

the latter part of the month and the first of August raised the streams so that no difficulty has occurred since. Plans have been prepared for repairing the Schoharie Creek dam by putting on a new deck and apron and filling above the dam with gravel; but I doubt if any permanent improvement can be made to this structure, owing to its original faulty construction. It is only expected that the repairs will make the structure of some service until a new one can be built.

I would suggest that investigations be made as soon as practicable to ascertain what increase can be made to the water supply to the Erie canal on this division, either by the addition of new feeders or the construction of storage reservoirs to regulate the flow of the present ones. With a supply barely sufficient for the canal as now constructed, it will certainly be inadequate for the enlarged prism.

This department has been engaged during the past year in preparing plans for and superintending the construction of work authorized by the Legislature in the extraordinary repairs to the canals and elsewhere about the State, as will appear in the accompanying tables. In preparing plans, at the request of the Superintendent of Public Works, for repairing structures and various other work incident to the maintenance of the canals; also in making surveys and maps to be used in defense of actions for damages brought against the State before the Board of Claims. Our principal efforts, however, have been directed in making the surveys and preparing the plans for deepening the Erie canal to a depth of nine feet, and the Champlain canal to a depth of seven feet, in accordance with the law known as chapter 79, Laws of 1895.

For the purpose of carrying on the work expeditiously, the Erie canal was divided into six sections, averaging eighteen miles each, and the Champlain canal into three sections of twenty-two miles each. On the 12th of January you appointed from the Civil Service lists, and assigned to this division, seven assistant engineers, ten levelers, nineteen rodmen and thirty chainmen. These men, with those who could be spared from the regular official force, were divided into nine parties with,

Mr. Dorlon Clark, leveler, in charge of section No. 1, Erie canal.

Mr. W. L. Lawton, assistant engineer, in charge of section No. 2, Erie canal.

Mr. L. B. Sebring, leveler, in charge of section No. 3, Erie canal.

Mr. F. A. Bagg, assistant engineer, in charge of section No. 4, Erie canal.

Mr. C. W. Turnbull, assistant engineer, in charge of section No. 5, Erie canal.

Mr. M. H. Ranney, assistant engineer, in charge of section No. 6, Erie canal.

Mr. John G. Tait, assistant engineer, in charge of section No. 1, Champlain canal.

Mr. Monroe Warner, assistant engineer, in charge of section No. 2, Champlain canal.

Mr. M. P. Quintana, assistant engineer, in charge of section No. 3, Champlain canal.

The parties immediately commenced work in establishing base lines and benches and taking cross-sections at intervals of one hundred feet or less, if the case required. The surveys also included data for a new set of canal maps, as there has been many changes in the canals since the enlargement which are not recorded on the maps now in use. Owing to the severe cold weather progress was rather slow, and it was found necessary to appoint some laborers for each corps to assist in removing snow and ice so that the cross-sections could be taken. The work was all completed, however, before the opening of navigation.

The law provided that the deepening of the prism might be done by raising or lowering or raising and lowering. The problem was found to be much more intricate than at first anticipated. To decide in what manner a level should be deepened involved the question of cost of changing structures to conform to the new conditions. The obstruction of streams, the change of grade of railroads, streets and highways crossing the canals, the damages to private property, the relative cost and quantity of materials at different locations, etc., all of which have been carefully considered, and I believe the plans as submitted to you represent the most eco-

nomical manner of doing the work well. Of course, they might be greatly improved, but we have endeavored to make the work fit the appropriation, and have been compelled to make it severely plain, but, I trust, substantial.

Letting plans have been prepared for the following contracts for work to be done the coming winter:

Contracts.	Location	Distance Miles	Estimated Cost.
No. 1.	From lock 18 to lock 19, Erie canal......	8.86	$196,106
No. 2.	From lock 20 to lock 21, Erie canal......	3.32	57,688
No. 3.	From lock 27 to lock 28, Erie canal......	5.21	75,028
No. 4.	From lock 28 to lock 29, Erie canal......	1.97	33,251
No. 5.	From lock 32 to lock 33, Erie canal......	5.11	90,532
No. 6.	From lock 33 to lock 34, Erie canal......	2.57	45,080
No. 7.	From lock 42 to lock 44, Erie canal......	2.96	129,264
No. 8.	From Waterford side-cut to lock No. 5, Champlain canal......................	1.30	66,270
No. 9.	From lock 6 to lock 7, Champlain canal..	3.00	98,300
No. 10.	From lock 15 to lock 16, Champlain canal.	11.75	245,188
No. 12.	From lock 22 to bridge 157, Erie canal...	3.29	87,740
No. 13.	From lock 44 to lock 45, Erie canal......	1.24	41,860

Contract No. 11, which is to be partly paid for from an appropriation under chapter 320, Laws of 1895, and the balance to be paid from chapter 79, Laws of 1895, consists of lengthening locks 21 and 22, Erie canal, and improving the prism between said locks.

EXTRAORDINARY REPAIRS.

Chapter 105, Laws of 1895.

This act appropriated $12,000 for building a vertical wall along the berme bank of the Champlain canal through the village of Schuylerville. The contract was let to Messrs. Cunningham & Monty, August 19, 1895. The work was completed May 1, 1896.

Chapter 141, Laws of 1895.

This act appropriated $4,000 for building a new iron bridge over the Erie canal at High street in the city of Cohoes in place of the

old cast-iron structure, which was unsafe and had been condemned. The contract was let to the Groton Bridge Company, April 13, 1895. The bridge was completed February, 1896.

Chapter 176, Laws of 1895.

This act appropriated $2,000 for lengthening both ends of the culvert on Saratoga street in the village of Waterford. This culvert spans a small stream known as Cemetery creek, which crosses the street and empties into the Champlain canal. The canal forms a basin or cove along the street at this place for a distance of five or six hundred feet, which narrows the street down to width of thirty feet, and as a portion of it was occupied by a street railway, it made an exceedingly dangerous driveway. The culvert is now fifty-eight feet long and the basin has been filled in to make the street of a corresponding width. The above appropriation was only sufficient to build the necessary masonry, and a further appropriation of $2,000 was granted under chapter 215, Laws of 1896, for the filling. The contract for lengthening the culvert was let to Ira Parker, August 26, 1895, and was completed May, 1896. The work under the second appropriation was done under the direction of the Superintendent of Public Works.

Chapter 284, Laws of 1895.

This act appropriated $8,000 for building a vertical wall along the berme side of the Glens Falls feeder between Maple and Pearl streets in the village of Sandy Hill. The contract was let to W. J. Dempsey, October 9, 1895, and was completed May 1, 1896.

Chapter 286, Laws of 1895.

This act appropriated $10,000 for extending the heavy retaining wall at the guard lock on the Glens Falls feeder and such other repairs to the feeder as may be necessary. Five years ago a heavy retaining wall was built from the guard lock along the berme side of the feeder for a distance of one hundred and twenty-five feet. Beyond this was an old wall of poor construction which leaked badly and was not considered safe to withstand the pressure of water against it, and was a menace to valuable property. Plans

were prepared to extend the retaining wall one hundred and fifteen feet and for building three hundred feet of vertical wall to replace the old wooden docking below this point; also for building a steel bridge and berme abutment at Maple street in the village of Sandy Hill. The contract was let to Jeremiah Adams, October 9, 1895, and the walls were completed May 1, 1896. An additional appropriation of $1,500 was granted under chapter 796, Laws of 1896, for completing the approaches to the Maple street bridge, the work to be done in conjunction with the above. A supplementary contract was made with Mr. Adams for this work, dated September 10, 1896. The work is now under way.

Chapter 320, Laws of 1895.

This act appropriated $77,500 for lengthening locks 21 and 22, Erie canal. As stated in my last report, plans were prepared for this work, but it was not advertised, as the estimated cost exceeded the appropriation. The Canal Board have since authorized that the work be done in connection with the general improvement, under chapter 79, Laws of 1895, and that the deficiency be paid from that fund. The contract was let to Chambers & Casey, September 10, 1896.

Chapter 492, Laws of 1895.

This act appropriated $2,000 for rebuilding the sidewalks at the State street bridge in the city of Schenectady. The old sidewalks had previously been condemned. The contract was let to the Rochester Bridge and Iron Works, November 16, 1895, and the work was finished during the following winter.

Chapter 680, Laws of 1896.

This act appropriated $8,000 for building an iron bridge and towing-path abutment at German street in the city of Little Falls. The contract was let to the Rochester Bridge and Iron Works, November 10, 1896, but owing to the contemplated improvements to the canals, which will probably involve some change in the alignment of the prism at this point, the work of erecting the bridge has been deferred.

Chapter 838, Laws of 1895.

This act appropriated $15,000 for building a sea-wall along the old State road between East Marion and Orient, in the county of Suffolk, to protect the highway from the encroachment of the sea. The contract was awarded to P. J. Brummelkamp, August 30, 1895, and the work was completed the following December. Chapter 950, Laws of 1896, appropriated $1,000 in addition to the balance of the funds left on the above contract for placing a coping on said wall. James J. Dwyer received the contract for this work, August 18, 1896. The coping is to be of concrete made with sea gravel and Portland cement.

Chapter 932, Laws of 1895.

This act appropriated $12,800 for work on the Shinnecock and Peconic canal, and $5,200 for dredging a channel from Shinnecock bay to the ocean. Shinnecock bay is a shallow sheet of water about twenty square miles in area. It is separated from the ocean by a strip of land from one to two thousand feet wide. This land is low and flat, being only three or four feet above mean high tide, excepting at the beach, where the dunes rise to an elevation of twenty to thirty feet above sea level. The object to be obtained is to open an inlet from the ocean of sufficient capacity to permit a free circulation of the waters of the ocean into the bay. The latter has now become stagnant, and in warm weather emits a disagreeable odor which is detrimental to the health of the many persons whose homes are in that vicinity; also to restore the fishing, oyster and clam industries for which Shinnecock bay was famous before the old inlet closed. The problem is one in which the element of chance largely figures. The theory on which it is being worked is to raise the surface of the water in the bay three feet above its normal level, and at a favorable condition of the ocean tides (which are sometimes two feet below mean low tide) to cut an opening through the dunes to let the water rush out of the bay, which would then be acting under a head of five feet, and is expected to cut a channel from ten to twenty rods wide and from ten to fifteen feet deep. At the place selected for the inlet a channel thirty feet

wide at bottom and six feet deep has been dredged from the bay to the foot of the dunes, about three hundred feet from the ocean. For the purpose of raising the water in the bay a set of automatic tide gates has been placed in the canal leading from Peconic Bay into Shinnecock bay. The tide in this canal ordinarily rises and falls about two feet, and in severe northeast storms it rises four to five feet. The gates open toward Shinnecock, permitting a free flow of water when the current is in that direction, and are closed by the action of the current as soon as the tide turns. They have been tested and worked very satisfactorily. The work has all been done in a substantial manner and everything indicates favorable results. The inlet will not be cut until midwinter, when the ocean tides are usually at the lowest stages. The contract for the above work was awarded to P. J. Brummelkamp, October 23, 1895. An additional appropriation of $5,000 was granted under chapter 950, Laws of 1896, for some extra dredging at the inlet which was not provided for in the previous appropriation, and also for dredging out a portion of the canal which had become badly choked up with deposits of sand. A supplementary contract was made with Mr. Brummelkamp for this work.

Chapter 963, Laws of 1895.

This act appropriates $15,000 for dredging the Albany basin to a depth not exceeding ten feet. A survey of the basin showed 76,000 cubic yards of material to be removed to obtain the required depth. Bids were received for dredging 50,400 cubic yards. As the contract was let at a price considerably below the estimated cost, the work was continued until stopped by cold weather. The total amount dredged was 64,565 cubic yards. There is still a small balance of this fund left, and I would recommend that an additional appropriation be granted, sufficient to complete the work. The contract was awarded to P. J. Myers & Son, August 26, 1895.

Chapter 1009, Laws of 1895.

This act appropriated $3,840.50 for rebuilding the center pier and repairing the draw-bridge over Wappinger's creek, in the village of New Hamburgh. The contract was awarded to Frank Pidgeon, October 9, 1895, and was completed January, 1896

Chapter 254, Laws of 1896.

This act appropriated $4,000 for building a new steel bridge over the Champlain canal at Bullard's farm, near the village of Schuylerville. The contract was let to Cunningham & Monty, June 10, 1896. The work is all completed, excepting some vertical wall in the prism to protect the berme approach.

Chapter 364, Laws of 1896.

This act appropriated $5,000 for building a culvert at Second street, in the village of Waterford, over the stream that flows from the weigh lock to the Hudson river, and also for some vertical wall along the banks of said stream. The contract was let to Michael Bennett, September 25, 1896.

Chapter 320, Laws of 1896.

This act appropriated $10,000 for continuing the surveys of the upper Hudson river valley. By an agreement with the Director of the U. S. Geological Survey, one-half of the above appropriation was to be used for completing the topographical survey of this part of the State, said director agreeing, on the part of the United States, to expend an equal amount upon the work, the topographical surveys to be made under the direction of the U. S. Geological Survey. The remaining $5,000 was to be expended in making surveys to locate particular sites for dams, establishing the lines of flow for securing the full storage available at the various reservoir sites. This work is in charge of Mr. George W. Rafter.

Chapter 480, Laws of 1896.

This act appropriated $10,000 to co-operate with the U. S. Geological Survey in making a topographical survey and map of this State, the Director of the U. S. Geological Survey to expend an equal amount on the part of the United States upon said survey. The work is in charge of the Director of the U. S. Geological Survey.

Chapter 947, Laws of 1896.

This act appropriated $125,000 for the eastern division to be expended in rebuilding or repairing structures and other essential

work not included under ordinary repairs. It has been customary to grant special appropriations for this class of work, which were usually either excessive or insufficient for the particular piece of work intended, and as the funds could be used only for the purposes designated in the act, it resulted in leaving some jobs incomplete or imperfectly done, while a surplus remained on others. The present method has proved to be very desirable and much necessary work is being done.

As mentioned in my last report, the channels of nearly all of the creeks crossing under the Erie canal on this division are filled with debris, causing the water to overflow the adjacent lands, resulting in numerous claims for damages, and the deposits underneath the aqueducts and culverts have reduced the waterways to such an extent as to seriously endanger the structures in case of heavy rains. Surveys and estimates have been made for restoring the channels and cleaning out ditches to insure proper drainage. This work is now being done by the Superintendent of Public Works. Lock No. 9 on the Champlain canal is to be rebuilt from this fund. This structure has been in bad condition for some years past. The masonry is of poor construction. Apparently there is no bond between the face stones and backing and the walls have bulged in toward the chamber. The face of the walls were cut back from two to five inches before the opening of navigation last season and the operation had to be repeated last spring. When the water was let into the canal some of the stones were forced out of the wall on the berme side of the lock and fell into the chamber. They were replaced and fastened with wooden wedges. By careful management the lock has been kept in working order up to the present time, though it has been a constant menace to navigation on this canal. The contract for rebuilding this lock was let to J. J. Cunningham, September 26, 1896.

Plans have also been prepared for repairing the Schoharie creek dam and bulkhead and the Cohoes dam, which was considerably damaged by ice during the spring freshet. Several other dilapidated structures will be rebuilt from this fund during the coming winter.

The accompanying tables show the contracts completed and final accounts rendered during the year, and the contracts pending September 30, 1896; also the expenses of this division, the names of persons employed, time of service and compensation of each.

During the past year this department has been under the direction of the undersigned as division engineer, Mr. A. J. Himes as resident engineer, Mr. T. C. Leutze as first assistant engineer for the Erie canal and Mr. John R. Kaley first assistant engineer for the Champlain canal. In addition to the regular work pertaining to this office, Mr. Leutze has been employed a considerable portion of the time in making surveys and maps for the Attorney-General to be used in defense of actions for damages brought before the Board of Claims. Mr. Kaley has had supervision of the work at quarantine station in the enlargement of Hoffman island.

Respectfully submitted,

DEWITT C. SMITH,

Division Engineer.

Table of contracts on Eastern Division completed during the year ending September 3, 1896.

(No. 30)

NAME OF CONTRACTOR.	Date of contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Laws.	Engineer's estimate at contract prices.	Final estimate.	Remarks.
		Erie Canal.						
P. W. Myers & Son	Aug. 26, 1895	Dredging the Albany basin	$15,000 00	963	1895	$9,513 00	$12,186 64	
Rochester Bridge and Iron Works	Nov. 16, 1895	Removal of sidewalks, State Street bridge, Schenectady	2,000 00	492	1895	1,705 00	1,705 00	
Groton Bridge and Manuf. Co	April 13, 1895	Iron bridge at High st., Cohoes	4,000 00	141	1895	3,722 00	3,699 50	
		Champlain Canal.						
Ira Parker	Aug. 26, 1895	Extend and rebuild cemetery culvert at Waterford	2,000 00	176	1895	1,812 90	1,755 10	
Cunningham & Monty	Aug. 19, 1895	Repair berme bank at Schuylerville	12,000 00	105	1895	6,940 10	9,894 50	
Willian. J. Dempsey	Oct. 9, 1895	Wall at Glens Falls feeder between Maple and Pearl streets, Sandy Hill	8,000 00	284	1895	3,592 20	3,747 57	
		Miscellaneous.						
P. J. Brummelkamp	Aug. 30, 1895	Rebuilding sea wall between East Marion and Orient, Suffolk county	15,000 00	838	1895	11,105 00	12,163 24	
P. J. Brummelkamp	Oct. 23, 1895	Dredging a channel between Shinnecock bay and the Atlantic ocean	5,200 00 5,000 00	932 950	1895 1896	4,800 00	6,553 17	
Frank Pidgeon	Oct. 9, 1895	Repairs to draw bridge over Wappinger creek, Dutchess county	3,840 50	1009	1895	3,628 00	3,616 71	

(No. 13.)

Wall at Schuylerville.

Chapter 105, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$16 29	$8 95	$25 24
T. C. Leutze	Assistant engineer	3	6 00 per day	18 00	6 77	24 77
Dorlon Clark	Leveler	2	4 50 per day	9 00	5 02	14 02
Wallace Greenalch	Leveler	2	4 50 per day	9 00	4 52	13 52
F. J. Lempe	Rodman	1	3 50 per day	3 50	4 43	7 93
F. S. Strong	Rodman	5	3 50 per day	17 50	16 19	33 69
H. J. Richardson	Chainman	2	2 50 per day	5 00	6 77	11 77
Ralph Russell	Chainman	96	3 50 per day	338 00	60 59	398 59
George McDonald	Chainman	80	2 50 per day	200 00	36 08	236 08
						$765 61
Incidental Expenses.						
Livery					$52 00	
Postage and telegraph					75	
Miscellaneous					2 67	55 42
						$821 03

Shinnecock Bay Inlet.

(No. 18)

***Chapter* 932, *Laws of* 1895.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Guy H. Miller	Leveler	39	$4.50 per day.	$175 50	$2 45	$177 95
Henry F. Smith	Chainman	27	3 50 per day.	94 50	4 00	98 50
Total						$276 45

Geological survey, New York state.

(No. 28.) *Chapter 480, Laws of 1896.*

NAME.	Travel.
J. H. Jennings	$804 89
Frank Sutton	1,050 41
E. B. Clark	215 68
C. C. Bassett	279 89
A. M Walker	273 19
Nat. G. Van Doren	124 77
J. H. Wheat	238 71
M M. Crane	82 85
C. P. DeWitt	24 00
E. A. Andrews	231 15
Osborne House	128 00
Total	$3,453 04

The foregoing tables are summarized as follows:

(No. 29.)

Ordinary Repairs.

No. 1.	Erie canal, chapter 282, Laws 1895	$8,818 17	
2.	Champlain canal, chapter 282, Laws 1895	4,003 07	
			$12,821 24

Extraordinary Repairs.

3.	Improving Saranac river, chapter 109, Laws 1894	171 47	
4.	Drakes draw bridge, chapter 1009, Laws 1895	80 55	
5.	State Street bridge, Schenectady, chapter 462, Laws 1895	67 05	
6.	Repairs to Glens Falls feeder, chapter 284, Laws 1895	697 85	
7.	Wall at Glens Falls feeder, chapter 286, Laws 1895	824 36	
8.	Cemetery culvert, Waterford, chapter 176, Laws 1895	110 80	
9	German Street bridge, Little Falls, chapter 680, Laws 1895	199 55	
10.	Lengthening locks 21 and 22, Erie canal, chapter 320, Laws 1895	130 00	
11.	Repairs Rexford Flats dam, chapter 560, Laws 1895	398 44	
12.	Repairs, Smith's basin, Champlain canal chapter 298, Laws 1895	106 06	
13.	Wall at Schuylerville, chapter 105, Laws 1895	821 03	
14.	Dredging Albany basin, chapter 963, Laws 1895	803 30	
15.	Improving Indian lake, chapter 104, Laws 1895	70 50	
16.	State roads, St. Regis reservation, chapter 932, Laws 1895	56 69	
17.	Sea wall at Orient, chapter 838, Laws 1895	228 77	
18.	Shinnecock Bay Inlet, chapter 932, Laws 1895	276 45	
19.	Shinnecock and Peconic canal, chapter 932, Laws 1895, and chapter 950, Laws 1896	1,385 56	
20.	Cemetery culvert, Waterford, chapter 215, Laws 1896	119 19	
21.	Bullard's bridge, Champlain canal, chapter 254, Laws 1896	201 99	
22.	Repairs to Steele's creek, chapter 365, Laws 1896	403 77	
23.	Improvement, Erie canal, chapter 79, Laws 1895, and chapter 794, Laws 1896	56,971 96	
24.	Improvement, Champlain canal, chapter 79, Laws 1895, and chapter 794, Laws 1896	30,483 07	
			94,603 41

Special Surveys.

25.	Making surveys and maps for use of the State Board of Claims, chapter 932, Laws 1895	$5,136 30	
26.	Making surveys and maps required by State Engineer and Surveyor, chapter 932, Laws 1895	2,373 02	
27.	Upper Hudson River survey, chapter 599, Laws 1895, and chapter 320, Laws 1896	11,587 01	
28.	Geological survey New York State, chapter 480, Laws 1896	3,453 04	
			22,549 37
	Total		$129,974 02

(No. 27.)

Upper Hudson River Survey.

Chapter 599, *Laws of* 1895, *and Chapter* 320, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Engineer in charge	133	$10 00 per day	$1,330 00	$377 92	$1,707 92
A. M. Evans	Assistant engineer	16	5 00 per day	80 00	8 55	88 55
Wallace Greenalch	Leveler	36	4 50 per day	162 00	122 94	284 94
Foster B. Morss	Draftsman	99	5 00 per day	495 00	148 05	643 05
F. S. Strong	Rodman	16	3 50 per day	56 00	3 67	59 67
Seth Van Loan	Rodman	93	3 50 per day	325 50	6 33	331 83
Parkes D. Wendell	Chainman	98	2 50 per day	245 00	5 72	250 72
J. H. Jennings					773 85	773 85
W. M. Beaman					1,501 73	1,501 73
R. D. Cummin					512 85	512 85
Frank Sutton					548 72	548 72
E. B. Clark					315 31	315 31
L. E. Gregory					6 45	6 45
James McCormack					85 56	85 56
A. A. Ross					28 87	28 87
R. Guy Foster					7 05	7 05
W. J. Peters					1,037 22	1,037 22
W. H. Lovell					585 71	585 71
W. R. Waddell					101 00	101 00
						$8,871 00
Incidental Expenses.						
Labor				$1,193 42		
Miscellaneous				1,522 59		
						2,716 01
						$11,587 01

Examinations and Maps.

Chapter 950, Laws of 1896, and chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Engineer in charge	33	$10 00 per day	$330 00	$41 68	$371 68
Wallace Greenalch	Leveler	50	4 50 per day	225 00	16 33	241 33
C. H. Flanigan	Leveler	43	4 50 per day	193 50	496 76	690 26
F. N. Sanders	Rodman	50	3 50 per day	175 00	72 32	247 32
A. M. Evans	Rodman	18	3 50 per day	63 00	....	63 00
John J. Allen	Chainman	87	4 00 per day	348 00	....	348 00
						$1,961 59
Incidental expenses.						
Labor				$368 20		
Postage and telegraph				2 48		
Miscellaneous				40 75	....	411 43
						$2,373 02

(No. 25.)

State Board of Claims.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Hines	Resident engineer	....	$2,000 00 per year	$43 80	$55 03	$98 83
F. C. Lentze	Assistant engineer	246	6 00 per day	1,476 00	1,420 04	2,896 04
T. A. Hendrickson	Leveler	31	4 50 per day	139 50	67 24	206 74
Dorlon Clark	Leveler	13	4 50 per day	58 50	19 43	77 93
F. S. Strong	Leveler	10	4 50 per day	45 00	54 15	99 15
Guy H Miller	Leveler	20	4 50 per day	90 00	5 25	95 25
F. J. Lampe	Rodman	6	3 50 per day	21 00	15 02	36 02
F. S. Strong	Rodman	20	3 50 per day	70 00	71 73	141 73
Frank Roberts	Rodman	50	3 50 per day	175 00	145 18	320 18
L. B. Jones	Chainman	35	2 50 per day	87 50	53 98	141 48
H. J. Richardson	Chainman	25	2 50 per day	62 50	32 66	95 16
H. J. Richardson	Chainman	25	3 50 per day	87 50	83 17	170 67
Frank Lutz	Chainman	8	3 00 per day	24 00	30 01	54 01
Ralph Russell	Chainman	41	3 50 per day	143 50	107 66	251 16
Henry F. Smith	Chainman	10	3 50 per day	35 00	....	35 00
Wm. Van Epps	Chainman	3	2 50 per day	7 50	20 43	27 93
						$4,747 28
Incidental expenses.						
Labor				$1 00		
Livery				184 00		
Postage and telegraph				31 02		
Miscellaneous				173 00	....	389 02
						$5,136 30

Repairs to Glens Falls Feeder.

(No. 6.)

Chapter 284, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	Assistant engineer	20	$6 00 per day	$120 00	$18 87	$138 87
F. J. Lempe	Leveler	60	4 50 per day	270 00	55 83	325 83
F. S. Strong	Rodman	1	3 50 per day	3 50	4 90	8 40
Frank Lutz	Chainman	56	2 50 per day	140 00	7 42	147 42
William Van Epps	Chainman	19	2 50 per day	47 50	2 33	49 83
						$670 35
Incidental expenses.						
Livery				$27 50		27 50
						$697 85

(No. 7.)

Wall at Glens Falls Feeder.

Chapter 286, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	Assistant engineer	8	$6 00 per day	$48 00	$7 88	$55 88
F. J. Lempe	Leveler	64	4 50 per day	288 00	77 46	365 46
Frank Lutz	Chainman	52	2 50 per day	130 00	6 70	136 70
William Van Epps	Chainman	85	2 50 per day	212 50	7 28	219 78
						$777 82
Incidental expenses.						
Livery				$28 00		
Miscellaneous				18 54		46 54
						$824 36

(No. 11.)

Rexford Flats Dam.

***Chapter* 560, *Laws of* 1895.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C. Huestis	Assistant engineer	60	$5 00 per day	$300 00	$25 13	$325 13
H. J. Richardson	Chainman	16	2 50 per day	40 00	....	40 00
Frank Lutz	Chainman	3	2 50 per day	7 50	8 81	16 31
						$381 44
Incidental expenses.						
Livery				$12 00	....	12 00
						$393 44

(No. 10.)

Lengthening Locks Nos. 21 and 22, Erie Canal.

Chapter 320, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. C Huestis	Assistant engineer	26	$5 00 per day	$130 00	....	$130 00

German Street Bridge, Little Falls.

(No. 9.)

Chapter 680, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. C. Lentze	Assistant engineer	5	$6 00 per day	$30 00	$12 40	$42 40
T. A. Hendrickson	Leveler	1	4 50 per day	4 50	4 06	8 56
L. B. Jones	Chainman	2	2 50 per day	5 00	4 76	9 76
						$60 72
Incidental expenses.						
Miscellaneous				138 83	....	138 83
						$199 55

Cemetery Culvert, Waterford.

(No. 8.) *Chapter* 176, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	Assistant engineer	6	$6 00 per day	$36 00	$2 80	$38 80
F. J. Lempe	Rodman	20	3 50 per day	70 00	2 00	72 00
Total						$110 80

(No. 31.)

Table of Contracts Pending on the Eastern Division, September 30, 1896.

Erie Canal.

NAME OF CONTRACTOR.	Date of Contract.	Character of work.	Appropriation.	Legislative Act. Chapter.	Legislative Act. Year.	Engineer's preliminary estimate.	Engineer's estimate at contract prices.	Payments to date.
Rochester Bridge & Iron Wks.	Nov. 16, 1895	New bridge and abutments at German street, Little Falls	$8,000 00	680	1895	$7,104 50	$7,445 40	$2,499 00
Chambers and Casey	Sept. 7, 1896	Lengthening locks 21 and 22, and for other work incident thereto	87,500 00	79, 320 794	1895 1896	116,396 40	96,303 90	
Champlain Canal.								
Cunningham & Monty	June 10, 1896	For an iron bridge and approaches at the Bullard farm, Northumberland	4,000 00	254	1896	3,514 88	3,400 70	952 00
Michael Bennett	Sept. 26, 1896	Constructing stone arch culvert over the weigh lock outlet at Second street, and for outlet walls between Second street and Hudson river at Waterford, N. Y.	5,000 00	364	1896	3,925 25	3,641 75	
Jeremiah Adams	Oct. 11, 1895 Sept. 10, 1896	Walls, etc., on the Glens Falls feeder between Glens Falls and Sandy Hill	10,000 00 1,500 00	286 796	1895 1896	8,813 10 1,130 12	7,343 60	6,324 00
John J. Cunningham	Sept. 26, 1896	Rebuilding lock No. 9 (Becker's lock)		947	1896	27,142 80	27,447 00	
Miscellaneous.								
P. J. Brummelkamp	....	Piling and protecting banks, Shinnecock and Petonic canal	12,800 00 5,000 00	932 950	1895 1896	10,693 40 4,000 00	10,671 50 4,000 00	10,319 00
James J. Dwyer	Aug. 18, 1896	For concrete coping on sea wall between East Marion and Orient, Suffolk Co.	1,000 00	838 950	1895 1896	2,040 00	1,700 00	

Improvement Erie Canal.

(No. 23.)

Chapter 79, Laws of 1895, and chapter 794, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$728 38	$200 08	$928 46
T. C. Lentze	First assistant engineer	104	6 00 per day	624 00	347 98	971 98
C. C. Huestis	Assistant engineer	233	5 00 per day	1,165 00	67 39	1,232 39
A. M. Evans	Assistant engineer	122	5 00 per day	610 00	11 68	621 68
W. L. Lawton	Assistant engineer	225	5 00 per day	1,125 00	202 83	1,327 83
M. H. Ranney	Assistant engineer	226	5 00 per day	1,130 00	194 11	1,324 11
C. W. Trumbull	Assistant engineer	225	5 00 per day	1,125 00	513 95	1,638 95
F. A. Bagg	Assistant engineer	225	5 00 per day	1,125 00	148 52	1,273 52
George W. Rafter	Engineer in charge	82	10 00 per day	820 00	201 50	1,021 50
F. E. Spinner	Leveler	226	4 50 per day	1,017 00	83 06	1,100 06
H. P. Willis	Leveler	225	4 50 per day	1,012 50	61 98	1,074 48
Douglas Cornell	Leveler	225	4 50 per day	1,012 50	28 79	1,041 29
Lewis Sebring	Leveler	120	4 50 per day	540 00	138 94	678 94
Dorlon Clark	Leveler	225	4 50 per day	1,012 50	344 00	1,356 50
F. N. Sanders	Leveler	227	4 50 per day	1,021 50	76 71	1,098 21
F. S. Strong	Leveler	223	4 50 per day	1,003 50	114 03	1,117 53
F. J. Lempe	Leveler	26	4 50 per day	117 00	1 55	118 55
Guy H. Miller	Leveler	26	4 50 per day	117 00	....	117 00
C. D. Burrus	Draughtsman	194	4 50 per day	873 00	37 27	910 27
F. B. Morss	Draughtsman	122	4 50 per day	549 00	33 47	582 47
G. L. Schillner	Draughtsman	185	4 50 per day	832 50	2 30	834 80
Alexander Haring	Rodman	226	3 50 per day	791 00	35 00	826 00
O. J. Dempster	Rodman	225	3 50 per day	787 50	36 76	824 26
C. E. Gordon	Rodman	206	3 50 per day	721 00	28 96	749 96
F. Edwards	Rodman	225	3 50 per day	787 50	17 32	804 82
Seth Van Loan	Rodman	132	3 50 per day	462 00	23 07	485 07
E. G. Blessing	Rodman	225	3 50 per day	787 50	56 31	843 81
Sanford Vossler	Rodman	206	3 50 per day	721 00	26 89	747 89
A. H. Seabury	Rodman	75	3 50 per day	262 50	19 38	281 88
L. M. Schofield	Rodman	102	3 50 per day	357 00	50 01	407 01
H. De Graff	Rodman	225	3 50 per day	787 50	68 78	856 28
A. T. Blessing	Rodman	225	3 50 per day	787 50	80 27	867 77
Clarance Newman	Rodman	120	3 50 per day	420 00	44 90	464 90
Frank Roberts	Rodman	125	3 50 per day	437 50	40 12	477 62
C. M. Pepson	Rodman	61	3 50 per day	213 50	34 77	248 27
Matthew O'Connor	Chainman	86	2 50 per day	215 00	35 54	250 54
George Kirk, Jr	Chainman	222	2 50 per day	555 00	38 90	593 90

W. H. Conly	Chainman	33	2 50 per day	82 50	8 72	91 22
C. J. Reardon	Chainman	226	2 50 per day	565 00	55 77	620 77
A. A. Munson	Chainman	32	2 50 per day	80 00	7 29	87 29
W. B. Dwyer	Chainman	206	2 50 per day	515 00	42 23	557 23
F. Bartlett	Chainman	225	2 50 per day	562 50	57 49	619 99
J. M. Tiffney	Chainman	225	2 50 per day	562 50	39 76	602 26
J. G. Stewart	Chainman	225	2 50 per day	562 50	44 83	607 33
W. H. H. Klinkhart	Chainman	225	2 50 per dry	562 50	25 13	587 63
Jesse Patrick	Chainman	68	2 50 per day	170 00	11 07	181 07
I. I. Yates	Chainman	219	2 50 per day	547 50	50 03	597 53
A. F. Pfau	Chainman	225	2 50 per day	562 50	45 62	608 12
L. Dederick	Chainman	225	2 50 per day	562 50	64 67	627 17
L. Potter	Chainman	225	2 50 per day	562 50	65 22	627 72
F. Kromer	Chainman	225	2 50 per day	562 50	85 51	648 01
John Weeks	Chainman	225	2 50 per day	562 50	56 03	618 53
W. J. Gilmore	Chainman	227	3 50 per day	794 50	79 68	874 18
Parkes D. Wendell	Chainman	127	2 50 per day	317 50	57 22	374 72
W. B. Strong	Chainman	226	2 50 per day	565 00	80 78	645 78
James T. Brady	Chainman	227	2 50 per day	567 50	88 76	656 26
G. H. Maulthrop	Chainman	225	2 50 per day	562 50	44 40	606 90
C. R. Conklin	Chainman	225	2 50 per day	562 50	63 56	626 06
H J. Richardson	Chainman	196	3 50 per day	686 00	70 36	756 36
Wm. Van Epps	Chainman	53	2 50 per day	132 50	44 23	176 73
Frank Lutz	Chainman	50	3 00 per day	150 00	....	150 00
Henry F. Smith	Chainman	52	3 50 per day	182 00	1 40	183 40
						$42,832 76

Incidental expenses.

Labor	$6,408 28		
Livery	3,872 40		
Office rent	590 45		
Fuel	6 00		
Stationery	1,521 17		
Postage and telegraph	173 48		
Miscellaneous	1,567 42		
		....	14,139 20
	....	....	$56,971 96

(No. 24.)

Improvement Champlain Canal.

Chapter 79, *Laws of* 1895, *and chapter* 794, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$640 48	$229 28	$869 76
John R. Kaley	First assistant engineer	166	6 00 per day	996 00	140 12	1,136 12
Wallace Greenalch	Assistant engineer	7	5 00 per day	35 00	9 65	44 65
Monroe Warner	Assistant engineer	225	5 00 per day	1,125 00	489 82	1,614 82
John G. Tait	Assistant engineer	224	5 00 per day	1,120 00	451 32	1,571 32
M. P. Quintana	Assistant engineer	219	5 00 per day	1,095 00	265 88	1,360 88
A. M. Evans	Assistant engineer	25	5 00 per day	125 00	9 16	134 16
M. W. Brown	Leveler	225	4 50 per day	1,012 50	107 91	1,120 41
L. B. Jones	Leveler	225	4 50 per day	1,012 50	91 60	1,104 10
T. A. Hendrickson	Leveler	226	4 50 per day	1,017 00	589 24	1,606 24
E. C. Clark	Leveler	225	4 50 per day	1,012 50	4 66	1,017 16
W. W. Olney	Leveler	183	4 50 per day	823 50	....	823 50
F. J. Lempe	Leveler	79	4 50 per day	355 50	19 74	375 24
Guy H. Miller	Leveler	26	4 50 per day	117 00	11 52	128 52
G. L. Schillner	Draughtsman	36	4 50 per day	151 00	6 12	157 12
A. T. G. Wemple	Rodman	73	3 50 per day	255 50	1 81	257 31
H. F. Allen	Rodman	206	3 50 per day	721 00	2 66	723 66
W. R. Borst	Rodman	90	3 50 per day	315 00	46 80	361 80
W. S. Jones	Rodman	225	3 50 per day	787 50	80 63	868 13
Perry Filkins	Rodman	225	3 50 per day	787 50	1 93	789 43
C. H. Nichols	Rodman	225	3 50 per day	787 50	7 23	794 73
A. H. Seabury	Rodman	131	3 50 per day	458 50	....	458 50
C. M. Pepson	Rodman	17	3 50 per day	59 50	20 28	79 78
Frank Roberts	Rodman	44	3 50 per day	154 00	26 76	180 76
P. H. Ryan	Chainman	225	2 50 per day	562 50	4 01	566 51
George A. McNeal	Chainman	52	2 50 per day	130 00	19 79	149 79
H. S Miller	Chainman	225	2 50 per day	562 50	87 00	649 50
R. M. Booth	Chainman	225	2 50 per day	562 50	88 60	651 10
W. B. Ingalsbe	Chainman	206	2 50 per day	515 00	1 68	516 68
A. S. McMurray	Chainman	206	2 50 per day	515 00	1 68	516 68
W. E. Petty	Chainman	226	2 50 per day	565 00	1 93	566 93
F. G. Tilton	Chainman	225	2 50 per day	562 50	1 68	564 18
F. N. Owens	Chainman	206	2 50 per day	515 00	1 68	516 68
Jesse Patrick	Chainman	157	2 50 per day	392 50	2 83	395 33

Wm. Van Epps	Chainman	30	2 50 per day	75 00	10 01	85 01
George McDonald	Chainman	73	2 50 per day	182 50	3 86	186 36
Frank Lutz	Chainman	13	2 50 per day	32 50	2 08	34 58
Frank Lutz	Chainman	26	3 00 per day	78 00	7 14	85 14
Ralph Russell	Chainman	13	3 50 per day	45 50	6 00	51 50
						$23,114 07
Incidental expenses.						
Labor				$2,963 72		
Livery				2,526 00		
Office rent				125 73		
Fuel				2 50		
Stationery				754 32		
Postage and telegraph				69 51		
Miscellaneous				927 22	....	7,369 00
						$30,483 07

Statement showing names, rank, number of days and compensation of engineers employed on the Eastern Division of the New York State Canals, together with incidental expenses during the fiscal year ending September 30, 1896.

No. 1.) *Ordinary Repairs, Erie Canal, Chapter 282, Laws of 1895.*

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt Smith	Division engineer	....	$2,400 00 per year	$1,599 96	$340 67	$1,940 63
Albert J. Himes	Resident engineer	....	2,000 00 per year	325 98	99 07	425 05
C. C. Huestis	Assistant engineer	4	5 00 per day	20 00	7 70	27 70
A. M. Evans	Assistant engineer	26	5 00 per day	130 00	1 60	131 60
Guy H. Miller	Leveler	15	4 50 per day	67 50	12 50	80 00
T. A. Hendrickson	Leveler	60	4 50 per day	270 00	37 84	307 84
A. M. Evans	Leveler	26	4 50 per day	117 00	....	117 00
F. N. Sanders	Leveler	36	4 50 per day	162 00	3 91	165 91
F. A. Bagg	Leveler	10	4 50 per day	45 00	....	45 00
Dorlon Clark	Leveler	17	4 50 per day	76 50	9 50	86 00
C. M. Pepson	Rodman	210	3 50 per day	735 00	70 59	805 59
F. A. Bagg	Rodman	9	3 50 per day	32 00	....	32 00
A. M. Evans	Rodman	8	3 50 per day	28 00	3 80	31 80
F. S. Strong	Rodman	45	3 50 per day	157 50	12 83	170 33
F. N. Sanders	Rodman	4	3 50 per day	14 00	....	14 00
Frank Roberts	Rod an	10	3 50 per day	35 00	9 08	44 08
Guy H. Miller	Chainman	16	2 50 per day	40 00	10 40	50 40
H. J. Richardson	Chainman	18	2 50 per day	45 00	12 19	57 19
H. J. Richardson	Chainman	19	3 50 per day	66 50	31 95	98 45
Eugene H. Lilly	Chainman	270	3 50 per pay	945 00	28 85	973 85
George McDonald	Chainman	58	2 50 per day	145 00	29 48	174 48
Henry F. Smith	Chainman	66	3 50 per day	231 00	26 38	257 38
W. J. Gilmore	Chainman	36	2 50 per day	90 00	1 00	91 00
Wm. Van Epps	Chainman	44	2 50 per day	110 00	70 90	180 90
H. S. Miller	Chainman	10	2 50 per day	25 00	....	25 00
Frank Lutz	Chainman	29	3 00 per day	87 00	1 66	88 66
F. D. Haak	Chainman	10	4 00 per day	40 00	4 58	44 58
John J. Allen	Chainman	182	4 00 per day	728 00	78 41	806 41
						$7,272 83

Incidental expenses.			
Labor	$213 31		
Livery	46 00		
Office rent	16 00		
Fuel	2 63		
Stationery	455 90		
Postage and telegraph	149 10		
Miscellaneous	662 40		
		....	1,545 34
			$8,818 17

(No. 2.)

Ordinary repairs — Champlain Canal.

Chapter 282, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
De Witt C. Smith	Division engineer	....	$2,400 00 per year	$800 04	$112 82	$912 86
Albert J. Hines	Resident engineer	....	2,000 00 per year	65 88	8 27	74 15
John R. Kaley	Assistant engineer	10	6 00 per day	60 00	2 30	62 30
T. A. Hendrickson	Leveler	1	4 50 per day	4 50	1 60	6 10
F. A. Bagg	Leveler	26	4 50 per day	117 00	....	117 00
A. M. Evans	Leveler	10	4 50 per day	45 00	....	45 00
F. J. Lempe	Leveler	28	4 50 per day	126 00	8 78	134 78
C. M. Pepson	Rodman	29	3 50 per day	101 50	....	101 50
L. B. Jones	Rodman	37	3 50 per day	129 50	16 50	146 00
L. B. Jones	Chainman	13	2 50 per day	32 50	6 60	39 10
H. J. Richardson	Chainman	5	3 50 per day	17 50	13 99	31 49
Eugene H. Lilly	Chainman	54	3 50 per day	189 00	....	189 00
George McDonald	Chainman	106	2 50 per day	265 00	19 90	284 90
Henry F. Smith	Chainman	16	3 50 per day	56 00	6 00	62 00
Wm. J. Gilmore	Chainman	4	2 50 per day	10 00	6 39	16 39
Ralph Russell	Chainman	27	2 50 per day	67 50	97 75	165 25
Ralph Russell	Chainman	52	3 50 per day	182 00	9 30	191 30
Wm. Van Epps	Chainman	19	2 50 per day	47 50	....	47 50
Frank Lutz	Chainman	26	2 50 per day	65 00	....	65 00
F. D. Haak	....	74	4 00 per day	316 00	4 80	320 80
John J. Allen	....	88	5 00 per day	440 00	64 36	504 36
F. J. Lempe	Rodman	26	3 50 per day	91 00	3 60	94 60
						$3,611 38
Incidental expenses.						
Labor				$62 84		
Livery				47 00		
Stationery				58 75		
Postage and telegraph				59 49		
Miscellaneous				163 61	....	391 69
						$4,003 07

(No. 3.)

Improving Saranac River.

***Chapter* 169, *Laws of* 1894.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt C. Smith	Division engineer	....	....	....	$50 00	$50 00
T. C. Lentze	Assistant engineer	3	$6 00 per day	$18 00	18 07	36 07
H. J. Richardson	Chainman	5	3 50 per day	17 50	27 70	45 20
Wm. Van Epps	Chainman	5	2 50 per day	12 50	27 70	40 20
Total	....	....	....	....	....	$171 47

State Street Bridge, Schenectady (Sidewalks).

(No. 5.)

Chapter 462, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Charles F. Stowell	Inspection, etc			$17 05		
George P. Hilton	Plans, etc			50 00		
						$67 05

Repairs to Steele's Creek.

(No. 22.)

Chapter 365, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Ralph Russell	Chainman	79	$3 50 per day	$276 50	$127 27	$403 77

(No. 21.)

Bullard's Bridge, Champlain Canal.

Chapter 254, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Guy H. Miller	Leveler	27	$4 50 per day	$121 50	$11 49	$132 99
Incidental expenses.						
Miscellaneous				$69 00	....	$69 00
						$201 99

Cemetery Culvert, Waterford.

(No. 20.)

Chapter 215, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. J. Lempe	Leveler	8	$4 50 per day	$36 00	$4 60	$40 60
Frank Lutz.	Chainman	7	2 50 per day	17 50	7 70	25 20
William Van Epps	Chainman	9	2 50 per day	22 50	8 29	30 79
George McDonald	Chainman	6	2 50 per day	15 00	7 60	22 60
Total	....	....	....	....	....	$119 19

Drake's Draw Bridge.

(No. 4.)

Chapter 1009, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$10 86	$5 62	$16 48
T. A. Hendrickson	Leveler	7	4 50 per day	31 50	21 75	53 25
L. B. Jones	Chainman	2	2 50 per day	5 00	5 82	10 82
Total						$80 55

Shinnecock and Peconic Canal—Piling and Protecting.

(No. 19.) *Chapter* 932, *Laws of* 1895, *and chapter* 950, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$21 72	$29 46	$51 18
T. C. Lentze	Assistant engineer	5	6 00 per day	30 00	60 13	90 13
Guy H. Miller	Leveler	108	4 50 per day	486 00	87 39	573 39
F. S. Strong	Rodman	5	3 50 per day	17 50	25 67	43 17
H. J. Richardson	Chainman	4	2 50 per day	10 00	21 60	31 60
John J. Allen	Chainman	6	4 00 per day	24 00	35 76	59 76
H. F. Smith	Chainman	116	3 50 per day	406 00	48 29	454 29
Guy H. Miller	Chainman	13	2 50 per day	32 50	12 83	45 33
						$1,348 85
Incidental expenses.						
Livery				$29 50		
Postage and telegraph				1 86		
Miscellaneous				5 35	....	36 71
						$1,385 56

(No. 17.)

Sea Wall at Orient.

Chapter 838, *Laws of* 1895.

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
Guy H. Miller	Chainman	24	$2 50 per day	$60 00	$58 47	$118 47
Henry F. Smith	Chainman	27	3 50 per day	94 50	15 80	110 30
Total						$228 77

Improving Indian Lake.

(No. 15.)

***Chapter* 104, *Laws of* 1895.**

NAME:	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Charles Helms	Laborer			$8 25		$8 25
Horace Helms	Laborer			14 25		14 25
Albert Helms	Laborer			8 25		8 25
Marcellus Earl	Laborer			8 25		8 25
George King	Laborer			8 25		8 25
William King	Laborer			8 25		8 25
William Purdy	Laborer			6 75		6 75
George Ashlaw	Laborer			8 25		8 25
Total						$70 50

State Roads — St. Regis Reservation.

(No. 16.)

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
DeWitt C. Smith	Division engineer	....	....	....	$29 07	$29 07
L. B. Jones	Chainman	....	....	$7 50	20 12	27 62
Total	....	....	....	....	....	$56 69

Repairs Smith's Basin.

(No. 12.)

Chapter 298, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$97 74	$8 32	$106 06

Dredging Albany Basin.

(No. 14.)

Chapter 963, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Albert J. Himes	Resident engineer	....	$2,000 00 per year	$48 87	....	
Dorlon Clark	Leveler	64	4 50 per day	288 00	....	
A. M. Evans	Rodman	27	3 50 per day	94 50	....	
H. J. Richardson	Chainman	18	2 50 per day	45 00	....	
Frank Lutz	Chainman	50	2 50 per day	125 00	....	
W. J. Gilmore	Chainman	49	2 50 per day	122 50	....	
					....	$723 87
Incidental expenses.						
Office rent				$15 00		
Fuel				5 25		
Miscellaneous				59 18		
					....	79 43
				....	....	$803 30

APPENDIX V.

REPORT

OF THE

DIVISION ENGINEER

OF THE

MIDDLE DIVISION

FOR THE

Year Ending September 30, 1896.

REPORT

Division Engineer's Office,
Syracuse, N. Y., *September* 30, 1896.

Hon. Campbell W. Adams, *State Engineer and Surveyor*, *Albany, N. Y.:*

Dear Sir.— I have the honor to submit the following report concerning the operations of the engineering department on the middle division, New York State canals, during the fiscal year ending September 30, 1896:

The engineering force on the middle division consists, on the 30th day of September, of W. H. H. Gere, division engineer; Geo. A. Morris, resident engineer; A. C. Driscoll, first assistant engineer; 7 assistant engineers, 15 levelers, 9 rodmen, 23 chainmen, 7 laborers and 1 draughtsman.

From the beginning of the fiscal year until January 13th, when the improvement work was commenced, the force employed was limited to the actual necessity to care for the work contracted to be done under special acts of the Legislature, assisting the Superintendent of Public Works whenever called upon in any and all matters of ordinary and extraordinary repairs upon the division. To enumerate in detail the daily calls for plans, bills of timber and iron, surveys and estimates for ditches, cleaning feeders, repairs to locks, dams and other structures would require too much space to justify its embodiment in this report. The division and resident engineers have always endeavored to be prompt in carrying orders into execution, and I am happy to be able to attest to the faithful and efficient service of subordinate employees.

The only case of threatened break in the canal to which the engineering department has been called occurred at culvert No.

80, near the Wayne county line, on May 15th, and was temporarily repaired without delaying navigation a moment by faithful work for three days and nights. This culvert will need thorough repairs during the coming winter, as will also cluvert at Bloody brook on the Oswego canal.

IMPROVEMENT OF THE ERIE AND OSWEGO CANAL.

Chapter 79, Laws of 1895.

In addition to the supervision of work under ordinary and extraordinary repairs, on January 13th 8 assistant engineers, 12 levelers, 12 rodmen and 20 chainmen were appointed from the Civil Service eligible list and ordered to report to the division engineer for assignment to duty in connection with the improvement of the Erie and Oswego canals, pursuant to act, chapter 79, Laws of 1895.

Parties were at once organized under George C. Diehl, assistant engineer; office established at Utica.

Reeves Smith, assistant engineer, at Rome.

Marshall B. Palmer, assistant engineer, at Canastota.

David R. Lee, assistant engineer, at Syracuse.

W. W. Jeffers, assistant engineer, at Jordan.

C. E. Raynor, assistant engineer, at Port Byron.

J. C. Wait, assistant engineer, at Syracuse, Oswego canal.

H. C. Allen, assistant engineer, at Fulton, Oswego canal.

The first work undertaken was to establish a base line and benches over the whole division. Owing to the extreme cold weather progress was slow, but as all the future work depended upon the accuracy of the survey and benches, the utmost care was taken in doing the work.

After the base line and benches were satisfactorily fixed, the work of cross-sectioning every hundred feet, or less, if conditions required, was begun and continued to the close. Measurements of structures to be changed to fit the new conditions were made.

As the field work upon each assistant's section was completed

the party was employed in the office plotting cross-sections and plans and computing quantities preparatory to letting the work.

In the effort to arrive at correct quantities, that will be shown in the final account, after the completion of the work, innumerable questions have arisen, and while it has been impossible to anticipate all the conditions that may arise in the progress of the work, it is believed that in the aggregate the work will be done within the estimates unless material changes in the plans be made.

The work upon the middle division has been divided into forty-five contracts. For future reference I embody description and extent of each contract herein, as follows:

ERIE CANAL.

1. From the east line of Oneida county to a point 100 feet below lower hollow quoin of lock No. 46, 3.33 miles.

2. From a point 100 feet below lower hollow quoin of lock No. 49 to a point 100 feet below lower hollow quoin of lock No. 50, 4.94 miles.

3. From a point 100 feet west of upper hollow quoin of lock No. 50 to 100 feet west of the center of Camillus road bridge, 3.92 miles.

4. From a point 100 feet west of Camillus road bridge (113) to a point 100 feet west of the center of Peru road bridge, 6.31 miles.

5. From a point 100 feet west of the center of Peru road bridge to a point 100 feet west of the lower hollow quoin of lock No. 51, 4.68 miles.

12. Improving lock No. 46, and work connected therewith, extending from a point 100 feet below lower hollow quoin to a point 100 feet above upper hollow quoin, .0795 miles.

13. Improving lock No. 49 and work connected therewith, extending from a point 100 feet above upper hollow quoin to a point 100 feet below lower hollow quoin, .0795 miles.

14. Improving lock No. 50 and work connected therewith, extending from a point 100 feet below lower hollow quoin to a point 100 feet above the upper hollow quoin, .0795 miles.

17. Rebuilding Canasaraga creek culvert.

18. From a point 100 feet above upper hollow quoin of lock No. 46 to a point 100 feet west of Oriskany creek aqueduct, 5.95 miles.

19. From a point 100 feet west of Oriskany creek aqueduct to a point 100 feet west of Greenfield's road bridge, 6.67 miles.

20. From a point 100 feet west of Greenfield's road bridge to a point 100 feet west of Main street road bridge at New London, 8.45 miles.

21. From a point 100 feet west of Main street road bridge at New London to a point 100 feet west of Durhamville road bridge No. 63, 8.31 miles.

22. From a point 100 feet west of Durhamville road bridge to a point 100 feet west of New Boston road bridge, 9.04 miles.

23. From a point 100 feet west of New Boston road bridge to a point 100 feet west of Kirkville road bridge, 7.20 miles.

24. From a point 100 feet west of Kirkville road bridge to a point 100 feet east of Butternut creek aqueduct, 5.86 miles.

25. From a point 100 feet east of Butternut creek aqueduct to a point 100 feet east of the upper hollow quoin of lock No. 49, 5.30 miles.

26. From a point 100 feet west of the lower hollow quoin of lock No. 51 to a point 100 feet west of Centerport road bridge, 5.56 miles.

27. From a point 100 feet west of Centerport road bridge to a point 100 feet west of Crane brook aqueduct, 5.03 miles.

28. From a point 100 feet west of Crane brook aqueduct to the east line of Wayne county, 6.24 miles.

OSWEGO CANAL.

6. Building a stone apron to a portion of Phoenix dam and work connected therewith.

7. Raising Braddock's dam and work connected therewith.

8. Raising Minetto dam and work connected therewith.

9. Raising High dam and work connected therewith.

10. Raising Oswego dam and work connected therewith.

11. Improving Lake Ontario level from a point 100 feet below lower hollow quoin of lengthened lock No. 18 to a point in the bottom of harbor of Oswego, 10 feet below U. S. Datum, 0.28 miles.

15. Rebuilding and lengthening lock No. 18 and work connected therewith, extending from a point 100 feet above upper hollow quoin to a point 100 feet below lower hollow quoin of lengthened lock, .0795 miles.

16. From a point 100 feet below lower hollow quoin of guard lock No. 3 to a point 100 feet above upper hollow quoin to lock No. 11, 2.51 miles.

29. From the junction of the Oswego with the Erie canal at Syracuse to a point 100 feet below lower hollow quoin of lock No. 3, 1.98 miles.

30. From a point 100 feet below lower hollow quoin of lock No. 3 to a point 100 feet above the upper hollow quoin of lock No. 5 (Mud lock), 5.42 miles.

31. Improving lock No. 5, including work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 100 feet below the lower hollow quoin, .0795 miles.

32. From a point 100 feet below the lower hollow quoin of lock No. 5 to a point 100 feet above the upper hollow quoin of guard lock No. 1 at Phoenix.

33. Improving guard lock No. 1, including work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 100 feet below the lower hollow quoin, .0795 miles.

34. From a point 100 feet below the lower hollow quoin of guard lock No. 1 to end of lower wings of lock No. 7, 5.73 miles.

35. For dredging channel from end of lower wings of lock No. 7 to guard lock No. 3, 3.52 miles.

36. For raising towpath from lock No. 7 to guard lock No. 3 and work connected therewith, 3.56 miles.

37. For raising Oswego Falls dam and work connected therewith.

38. From a point 100 feet above the upper hollow quoin of lock No. 11 to a point 100 feet above the upper hollow quoin of lock No. 13, 4.90 miles.

39. Improving and lengthening lock No. 13, including work connected therewith, extending from a point 100 feet above the upper hollow quoin of lock No. 13 to a point 210 feet below the lower hollow quoin of the present lock, .0795 miles.

40. From a point 100 feet below the lower hollow quoin of the lengthened lock No. 13 to a point 100 feet above the upper hollow quoin of lock No. 18, excepting therefrom the lengthening and improving of locks Nos. 14, 15, 16, 17 and guard lock No. 5, together with the work connected therewith, 4.06 miles.

41. Improving and lengthening lock No. 14, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of present lock to a point 100 feet below the lower hollow quoin, .0795 miles.

42. Improving and lengthening lock No. 15, and work connected therewith, extending from a point 100 feet above the upper hollow quoin to a point 210 feet below the lower quoin of the present lock, .0795 miles.

43. Improving and lengthening lock No. 16, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a point 100 feet below the lower hollow quoin, .0795 miles.

44. Improving and lengthening guard lock No. 5, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a point 100 feet below the lower hollow quoin, .0795 miles.

45. Improving and lengthening lock No. 17, and work connected therewith, extending from a point 210 feet above the upper hollow quoin of the present lock to a point 100 feet below the lower hollow quoin, .0795 miles.

On August 26th last, plans and estimates for seventeen contracts were completed and delivered to the State Engineer and Surveyor. Plans and estimates for the remaining contracts will be prepared as soon as possible.

The following tables have been compiled, as required by law:

Table No. 1, hereto annexed, shows the names of the engineers duly appointed by the State Engineer and Surveyor, time employed,

rate of compensation and amount paid during the year, with the amount of other miscellaneous expenditures for ordinary and extraordinary repairs.

Table No. 2 exhibits contracts in force at the close of the fiscal year, together with engineer's estimate of cost of each piece of work and the amount paid thereon.

Table No. 3 exhibits contracts completed and settled, during the fiscal year, with the engineer's estimate, and the total cost of each piece of work as returned in final account.

Table No. 4 exhibits water record of Cayuga and Cross lakes and Seneca river taken triannually since 1884, in pursuance of concurrent resolutions of the Senate and Assembly, passed in 1884.

Extraordinary Repairs Done by Contract Under the Supervision of the Engineering Department, During the Fiscal Year.

CONTRACTS COMPLETED AND SETTLED.

STONE APRON AT OSWEGO DAM.

Chapter 572, Laws of 1894.

Let November 1, 1894, to J. B. Donnelly.

Appropriation	$30,000 00
Engineer's estimate	24,185 00
Payment prior to September 30, 1895	19,907 00
Payment since September 30, 1895	5,582 59
Final estimate	25,489 59

This work has fully demonstrated the superiority of cut stone for aprons to dams on the Oswego river.

BRIDGE AND APPROACHES OVER THE OUTLET OF OTISCO LAKE.

Chapter 497, Laws of 1895.

Let August 2, 1895, to E. S. Candee.

Appropriation	$8,000 00
Engineer's estimate	7,964 00
Payment prior to September 30, 1895	1,105 00
Payment since September 30, 1895	5,323 15
Final estimate	6,428 15

This work consists of building a bridge and approaches across the low ground at the head of Otisco lake, some 12 feet in height, and protecting the side slopes with stone wall to prevent washing.

IMPROVEMENT OF THE CAYUGA AND SENECA CANAL AT SENECA FALLS.

Chapter 512, Laws of 1895.

Let August 31, 1895, to Willard Johnson.

Appropriation	$20,000 00
Engineer's estimate	8,230 50
Payment prior to September 30, 1895	425 00
Payment since September 30, 1895	9,279 05
Final estimate	9,704 05

This work consists of removing two tow-path bridges, constructing stone arch culvert and vertical wall in cement on the short level of Cayuga and Seneca canal at Seneca Falls, a very great improvement to the canal, and saving cost of maintaining bridges.

The balance of appropriation to be applied to other work.

ROAD OVER SPILLWAY AT NORTH LAKE RESERVOIR.

Chapter 148, Laws of 1895.

Let August 28, 1895, to Michael Bennett.

Appropriation	$25,000 00
Engineer's estimate	3,853 50

Payments prior to September 30, 1895	$1,411 00
Payments since September 30, 1895	3,829 38
Final estimate	5,240 38

This work consits of erecting bridges over the spillway at North lake reservoir, lengthening the spillway and opening and improving the road. The balance of appropriation to be applied to other work at North lake.

STATE DITCH AT COWASSELON SWAMP.

Chapter 366, Laws of 1895.

Let August 29, 1895, to E. S. Gray.

Appropriation	$30,000 00
Engineer's estimate	21,350 00
Payments prior to September 30, 1895	1,360 00
Payments since September 30, 1895	26,166 25
Final estimate	27,526 25

This work consists of excavating a ditch 36 feet wide on bottom from near Canastota to Lakeport on shore of Oneida lake, 10 miles. Much more rock excavation was encountered than was anticipated at the time of preparing the estimate.

REPAIRS AT OWASCO LAKE OUTLET.

Chapter 99, Laws of 1895.

Let August 30, 1895, to J. J. Hallock.

Appropriation	$12,000 00
Engineer's estimate	12,000 09
Payments prior to September 30, 1895	442 00
Payments since September 30, 1895	9,638 72
Final estimate	10,080 72

This work consisted of erecting on the State dam new timber and plank flush frame and gates, and a pile protection upon the west side of the channel into the lake to prevent sand filling channel.

OPENING CHANNEL AT WIGWAM COVE, LAKE ONTARIO.

Chapter 1009, Laws of 1895.

Let September 3, 1895, to John Hannan.

Appropriation	$10,000 00
Engineer's estimate	10,000 00
Final estimate	8,541 90

This work was all done during this fiscal year, and consisted of dredging a channel 60 feet wide on bottom, from Lake Ontario to Wigwam cove. The channel can never be of advantage to lake commerce, as it can not be kept open, and could not be entered in a storm by any vessel if it were open, without piers extending into the lake. No practical advantage can be determined from further appropriation to this work.

REBUILDING PORTION OF COMBINED LOCKS 39 TO 43, BLACK RIVER CANAL.

Chapter 1030, Laws of 1895.

Let September 7, 1895, to Dodge & McGregor.

Appropriation	$45,000 00
Engineer's estimate	38,881 50
Final estimate	37,958 24

This work was all done during this fiscal year and consisted of rebuilding one-half of the five combined locks of cut limestone to replace the old locks, which were practically useless, being too narrow to admit passage of boats.

STEEL APRON TO PORTION OF BRADDOCK'S DAM, OSWEGO CANAL.

Chapter 572, Laws of 1894, and chapter 368, Laws of 1895.

Let September 9, 1895, to Hughes Brothers.

Appropriation	$25,000 00
Engineer's estimate	16,475 00
Payments prior to September 30, 1895	1,275 00
Payments since September 30, 1895	13,749 14
Final estimate	15,024 14

This work is described on page 325, report of 1895.

VERTICAL WALL BETWEEN TURNER AND GILBERT STREETS, UTICA.

Chapter 968, Laws of 1895.

Let September 17, 1895, to J. J. Dwyer.

Appropriation	$10,000 00
Engineer's estimate	9,993 50
Final estimate	7,373 28

VERTICAL WALL AT HIGGINSVILLE.

Chapter 299, Laws of 1895.

Let September 20, 1895, to Brayer, Albaugh, Lauer & Hagaman.

Appropriation	$2,500 00
Engineer's estimate	2,399 00
Final estimate	1,923 01

VERTICAL WALL AT CLAY STREET, UTICA.

Chapter 367, Laws of 1895.

Let September 20, 1895, to Brayer, Albaugh, Lauer & Hagaman.

Appropriation	$2,500 00
Engineer's estimate	2,499 50
Final estimate	2,019 37

PILING OUTLET AT LAKE KEUKA.

Chapter 1009, Laws of 1895.

Let September 20, 1895, to Brayer, Albaugh, Lauer & Hagaman.

Appropriation	$8,500 00
Engineer's estimate	8,414 00
Final account	6,655 99

This work consisted of a pile and sheet pile breakwater to protect the outlet at Lake Keuka.

STEEL SUPERSTRUCTURE FOR ROAD AND CHANGE BRIDGE AT SENECA FALLS.

Engineer's estimate	$1,550 00
Final estimate	1,550 00

The old superstructure fell into the canal a short time before the opening of the canal; as it was a change bridge it had to be built before the opening of the Cayuga and Seneca canal.

It was let to the Owego Bridge Company.

STEEL SUPERSTRUCTURE FOR THOMAS STREET BRIDGE AT ROME.

Chapter 970, Laws of 1895.

Let April 20, 1895, to King Bridge Co.

Appropriation, entire bridge	$7,000 00
Engineer's estimate	2,500 00
Final estimate	1,930 00

SUBSTRUCTURE FOR THOMAS STREET BRIDGE AT ROME.

Chapter 970, Laws of 1895.

Let April 20, 1895, to J. Louis Faass & Company.

Engineer's estimate	$3,426 00
Final estimate	3,518 90
Total cost of entire bridge	5,448 90

SUBSTRUCTURE FOR SWING-BRIDGE AT GARDEN STREET, ROME.

Chapter 965, Laws of 1895.

Let April 23, 1896, to Brumelkamp & Lane.

Appropriation for the entire bridge	$3,500 00
Appropriated by the city of Rome	3,500 00
Engineer's estimate	2,190 00
Final estimate	2,689 36

CONTRACTS IN FORCE SEPTEMBER 30, 1896.

PROTECTING CAYUGA AND SENECA CANAL AT GENEVA.

Chapter 142, Laws of 1895.

Let August 6, 1895, to E. H. Fleming & Company.

Appropriation	$15,000 00
Engineer's estimate	10,943 00
Payments prior to September 30, 1895	2,465 00
Payments since September 30, 1895	5,610 00
Total estimate	8,075 00

This work consisted of a dry vertical wall breakwater along the shore of Seneca lake.

IMPROVING CHANNEL AT SENECA RIVER AND OLD BEAR RACE AT WATERLOO.

Chapter 572, Laws of 1894, and chapter 512, Laws of 1895.

Let August 30, 1895, to G. W. Barlow.

Appropriation	$20,000 00
Engineer's estimate	14,297 50
Payments prior to September 30, 1895	221 00
Payments since September 30, 1895	9,367 00
Total estimate	9,588 00

This work consists of excavating channel in Old Bear race in rock, constructing a highway bridge across the same and controlling works at the head of the race to enable the State to control the water of the river for canal purposes.

DISCHARGE PIPES AT NORTH LAKE RESERVOIR.

Chapter 148, Laws of 1895.

Let August 29, 1895, to John H. Nelson.

Appropriation for this work includes road over spillway at North lake reservoir, constructed by Michael Burnett	$25,000 00
Engineer's estimate	17,983 50
Payments to September 30, 1895	12,410 00

This work consists of removing the old timber culvert in main dam of reservoir, and inserting five cast-iron pipes thirty inches in diameter, with necessary valves, well and gate-house.

IMPROVEMENT OF CAYUGA AND SENECA CANAL AND SENECA LAKE OUTLET.

Chapter 308, Laws of 1895.

Let October 1, 1895, to E. H. Fleming & Company.

Appropriation	$20,000 00
Engineer's estimate	13,600 00
Payments prior to September 30, 1895	442 00
Payments since September 30, 1895	11,968 00
Total payments	12,410 00

This work consists of constructing a timber dock protection on the berme side of Cayuga and Seneca canal, near Soap Mine bridge, stone piers and breakwaters at the outlet and dredging outlet and canal to Island D.

SUPERSTRUCTURE FOR SWING BRIDGE OVER BLACK RIVER CANAL AT GARDEN STREET, ROME.

Chapter 965, Laws of 1896.

Let April 21, 1896, to Havana Bridge Works.

Appropriation for entire bridge	$3,500 00
Appropriated by city of Rome	3,500 00
Engineer's estimate	3,184 00

No payments made under this contract.

SUPERSTRUCTURE FOR BRIDGE OVER BLACK RIVER AT CARTHAGE.

Chapter 102, Laws of 1895.

Let June 29, 1896, to Dunfee, Belden, Dwyer & Company.

Appropriation for entire structure, including superstructure	$25,000 00
Engineer's estimate	5,135 00
Payments to September 30, 1896	3,672 00

SUBSTRUCTURE FOR LIFT BRIDGE AT WEST GENESEE STREET, SYRACUSE.

Chapter 311, Laws of 1895, and Chapter 950, Laws of 1896.

Let July 1, 1896, to Brumelkamp & Lane.

Appropriation for the entire bridge	$12,500 00
Appropriated by the city of Syracuse	12,500 00
Engineer's estimate	10,655 00

No payments made under this contract.

SUPERSTRUCTURE FOR BRIDGE OVER BLACK RIVER AT CARTHAGE.

Chapter 102, Laws of 1895.

Let July 2, 1896, to Buffalo Bridge & Iron Works.

Appropriation for entire bridge	$25,000 00
Engineer's estimate	15,170 00
Payments to September 30, 1896	6,800 00

This work consists of constructing a seven-span steel superstructure over the Black river.

SUPERSTRUCTURE FOR LIFT-BRIDGE AT WEST GENESEE STREET, SYRACUSE.

Chapter 311, Laws of 1895, and Chapter 950, Laws of 1896.

Let July 3, 1896, to Hilton Bridge Company.

Appropriation for entire bridge	$12,500 00
Appropriated by city of Syracuse	12,500 00
Engineer's estimate	9,950 00

No payments made under this contract.

CHANGING AND RECONSTRUCTING BRIDGE AT GENESEE STREET, UTICA.

Chapter 170, Laws of 1895, and Chapter 950, Laws of 1896.

Let July 31, 1896, to Havana Bridge Company.

Appropriation	$25,000 00
Engineer's estimate	13,187 40

No payments under this contract.

This work consists of changing the machinery of operating lift-bridge and for changing the lifting and fixed bridges and their appurtenances, and for erecting two overhead foot-bridges over the Erie canal.

CONTINUING THE CONSTRUCTION OF BRIDGE AND APPROACHES OVER THE INLET TO OTISCO LAKE.

Chapter 793, Laws of 1896.

Let September 4, 1896, to Hughes Brothers.

Appropriation	$10,000 00
Engineer's estimate	8,318 00
Payments to September 30, 1896	2,431 00

This appropriation will build the embankment about two-thirds the way across the head of the lake, which will be of no benefit to the traveling public until the whole distance is completed, which will require a further appropriation of $10,000.

SUMMARY OF WORK DONE UNDER CONTRACT DURING THE FISCAL YEAR.

Stone apron at Oswego dam	$5,582 59
Bridge and approaches at Otisco lake	5,323 15
Improvement of Cayuga and Seneca canal at Seneca Falls	9,279 05
Road over spillway at North branch reservoir	3,829 38
State ditch at Cowasselon swamp	26,166 25
Repairs at Owasco lake outlet	9,638 72
Opening channel at Wigwam cove	8,541 90
Rebuilding portion locks 39 to 43, Black River canal	37,958 24
Steel apron at Braddock's dam	13,749 14
Vertical wall, Turner street, Utica	7,373 28
Vertical wall at Higginsville	1,923 01
Vertical wall at Clay street, Utica	2,019 37
Piling outlet at Lake Keuka	6,655 99
Superstructure road and change bridge at Seneca Falls	1,550 00
Superstructure for Thomas street bridge at Rome	1,930 00
Substructure for Thomas street bridge at Rome	3,518 90
Substructure for swing-bridge at Garden street, at Rome	2,689 36
Protecting Cayuga and Seneca canal at Geneva	5,610 00
Improving channel Seneca river and Old Bear race	9,367 00
Discharge-pipes at North lake reservoir	12,410 00
Improvement of Cayuga and Seneca canal and Seneca lake outlet	11,968 00
Substructure for bridge at Carthage	3,672 00
Superstructure for bridge at Carthage	6,800 00
Approaches, etc., at Otisco lake	2,431 00
Total	$199,986 33

WATER SUPPLY.

The question of an adequate water supply for the Erie canal after the improvement under act, chapter 79, Laws of 1895 is completed, is one that is well not to lose sight of, and it seems to be proper in this connection to anticipate the condition that will have to be met at no distant time.

The work under the improvement on the two summit levels, first extending from lock No. 46 at Utica to lock No. 47 at Syracuse, a distance of 56 miles, and second extending from lock No. 50, west of Syracuse, to lock No. 51, west of Jordan, a distance of 14.9 miles, provides for lowering the bottom of the prism of canal one foot and raising the surface of the water one foot.

These two levels must be supplied from reservoirs for impounded water accumulated mostly during the winter and early spring months. By the necessary excavation of the present canal bottom, which had become practically tight, will without doubt greatly increase the waste by percolation, to which must be added the increased amount of water required in locking boats and leakage at locks 46, 49 and 50, which will be one foot greater lift than now; also the additional amount of water required to fill the canal in the spring, and for any increase in the number of lockages during the season.

A conservative estimate is 25 per cent. as the probable increased amount of water that will be required to maintain the canals after the improvement is completed.

Where this water is to come from is a question of no little concern, and the conditions will have to be met before a continuous season of navigation can always be depended upon, with nine feet of water in the canal.

For a better understanding of the situation, I hereto attach a profile of the canal from the Utica to the Montezuma level, showing locks and feeders connected therewith.

PORT BYRON LEVEL.

The supply of the Port Byron level, 7.8 miles long, is derived from two sources, to wit: From lockages at lock No. 51 and from Owasco lake, entering the canal at Port Byron. While Owasco

lake is capable of providing the Port Byron level with a full supply of water, the present provision for conducting and distributing the water is entirely inadequate. The State dam at the foot of Owasco lake is of sufficient height to impound all the water required, if not permitted to go to waste. The large number of mills on the outlet, having their own mill dams, generally run in the day time and close down at night, allowing the mill ponds to fill during the night, thus cutting off the flow at Port Byron about one-half each day. This can only be overcome by constructing a distributing reservoir on the stream above Port Byron of sufficient capacity to hold a few days' supply, from which the canal could be fed continuously. The feeder extending from the Port Byron dam to the canal should be enlarged.

With this work done, there would be no necessity for drawing water from the west end of the Jordan level beyond that required for lockages.

JORDAN LEVEL.

This summit level is supplied almost entirely from Skaneateles lake and Otisco lake.

The city of Syracuse, in accordance with the act allowing said city to use the surplus water from Skaneateles lake as a water supply, constructed a new dam at the foot of the lake two feet higher than the crest of the old State dam, thus making it possible to raise the lake two feet. As the city has not yet liquidated the damage to property owners surrounding the lake for land to be flooded, the water in the lake has not been allowed to raise above the former height of the dam. The necessary steps should be taken to permit the filling of the lake to the crest of the present dam.

A small outlay at Otisco lake, lowering the channel from the lake to the dam, would, to some extent, increase the supply from that source.

By careful management at locks 50 and 51 no water need be drawn from the Jordan level, except what is necessary for locking boats.

For the Syracuse level there is sufficient water from lockages at locks 49 and 50 to maintain the level to proper height.

LONG LEVEL.

This summit level is supplied from Jamesville reservoir, Cazenovia lake, De Ruyter reservoir and Erieville reservoir, which enter the level at Butternut, Limestone and Chittenango creeks, small feeders at Oneida creek, from natural flow of streams. The Mohawk feeder at Rome and the Oriskany feeder at Oriskany are the principal supply for the eastern end of the level.

MOHAWK FEEDER.

The Mohawk feeder is supplied from reservoirs in the Adirondacks, to wit: Chub lake, Sand lake, Woodhull reservoir, Canachagala lake, North lake, South lake, Twin lakes, Forestport reservoir and Forestport pond.

White lake and the Bisbys were abandoned in pursuance of section 3, chapter 274, Laws of 1889. These lakes should be recovered and their waters restored to the Erie canal. Now the water flows into the Black river north of the summit and is lost to the Erie canal.

From long neglect and the temporary construction in the first place, most of the reservoirs in the woods have been allowed to go into general decay, so that much of the water is lost to the canals.

The photographs herewith presented will furnish you a fair idea of the condition existing at nearly all the reservoirs in northern Oneida and Herkimer counties.

I annex also a map showing the relative position of these lakes and reservoirs. During the past year much has been done to improve the condition of these reservoirs by making structures of a more permanent character than is possible with spruce logs.

For a more detailed description of work done, see report of George A. Morris, Resident Engineer, who has had immediate charge of this work.

ORISKANY FEEDER.

The Oriskany feeder is supplied from Eaton brook reservoir, Madison brook reservoir, Bradley brook reservoir, Hatches lake and Leland pond. These reservoirs are in good condition, needing

some repairs to valves and conveniences to handle them safely. The feeders require more or less bottoming out to permit a free flow to the summit level of the old Chenango canal, from whence the water passes into Oriskany creek and thence into the canal at Oriskany.

The Kingsley brook reservoir has been abandoned for several years after breaking away of the feeder. This reservoir should be restored and brought into use by repairing the lower dam and feeder to convey the water into the Eaton brook feeder.

The series of lakes in the Adirondack forests will furnish an adequate supply of water for the long level, if the structures and feeders are put and kept in proper repair, provided the State will disconnect itself from all responsibility, legal or otherwise, to supply water for running logs.

The owners of timber land deposit millions of feet of logs in the lakes during the winter, and in the spring they expect the State to furnish water to run the logs to Forestport, which practically empties the lakes, after which the State can be served if there is sufficient water from remaining snow and rainfall to fill the reservoirs again. By this process the interest of the State becomes secondary to that of the lumbermen. In my judgment the State should extinguish all the rights of the land owners, if they have any, to cut and run logs adjacent to the reservoirs and streams therefrom, by purchasing the land, if necessary to accomplish it, and to remove all chutes and other structures in dams provided for running logs. Any copartnership between the State and lumber interests works disastrously to the interests of the canals in practice, and ought not to be continued.

An expenditure of $75,000 a year for three years would put the reservoirs upon this division in serviceable condition, and, in my judgment, a full supply of water for the improved canal could be obtained.

By referring to tables two and three it will be noticed that there are eleven contracts in force on September 30th, and seventeen contracts have been completed and final accounts rendered during the fiscal year, covering an expenditure of $173,653.33.

In closing this report the Division Engineer begs leave to express his thanks to the State Engineer and Surveyor for his constant support and wise determination in all questions that have arisen during the past three years.

All of which is respectfully submitted,

W. H. H. GERE,

Division Engineer.

TABLE No. 1.

Statement showing the names, rank and compensation of engineers employed on the Middle Division of the New York State Canals, together with incidental expenses for the fiscal year ending September 30, 1896.

Improvement of the Erie Canal.

Chapter 79, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$962 81	$77 41	$1,040 22
George A. Morris	Resident engineer	....	2,000 00 per year	251 38	118 55	369 93
A. C. Driscoll	First assistant engineer	97	6 00 per day	582 00	127 84	709 84
George C. Diehl	Assistant engineer	225	5 00 per day	1,125 00	666 00	1,791 00
Reeves Smith	Assistant engineer	120	5 00 per day	600 00	326 05	926 05
M. B. Palmer	Assistant engineer	199	5 00 per day	995 00	216 17	1,211 17
David R. Lee	Assistant engineer	225	5 00 per day	1,125 00	631 40	1,756 40
W. W. Jeffers	Assistant engineer	225	5 00 per day	1,125 00	339 85	1,464 85
C. E. Raynor	Assistant engineer	193	5 00 per day	965 00	333 06	1,298 06
Edwin Styring	Leveler	2	4 50 per day	9 00	....	9 00
P. L. Schultze	Leveler	134	4 50 per day	603 00	8 48	611 48
S. J. Steward	Leveler	36	4 50 per day	162 00	2 12	164 12
E. D. Rich	Leveler	225	4 50 per day	1,012 00	6 84	1,019 34
M. A. McDermott	Leveler	225	4 50 per day	1,012 50	21 92	1,034 42
Noble E. Whitford	Leveler	213	4 50 per day	958 50	29 16	987 66
James G. Tracy	Leveler	170	4 50 per day	765 00	2 28	767 28
W. J. Town	Leveler	26	4 50 per day	117 00	....	117 00
Fred W. Sarr	Leveler	180	4 50 per day	810 00	16 74	826 74
L. H. Ireland	Leveler	167	4 50 per day	751 50	2 02	753 52
William Kelley	Leveler	167	4 50 per day	751 50	1 36	752 86
William A. Gere	Leveler	225	4 50 per day	1,012 50	62 92	1,075 42
E. A. Lamb	Leveler	174	4 50 per day	783 00	19 67	802 67
Arthur O'Brien	Leveler	5	4 50 per day	22 50	3 40	25 90
E. H. Thomes	Leveler	27	4 50 per day	121 50	....	121 50
John K. Lloyd	Draughtsman	80	4 50 per day	360 00	5 18	365 18
Fred J. Wagner	Rodman	72	4 50 per day	324 00	1 58	325 58
Arthur O'Brien	Rodman	82	3 50 per day	287 00	69	287 69
L. K. Devendorf	Rodman	36	3 50 per day	126 00	1 85	127 85

Improvement of the Erie Canal — (Continued).

Chapter 79, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
James Browne, Jr	Rodman	132	$3 50 per day	$462 00	....	$462 00
M. S. Smith	Rodman	37	3 50 per day	129 50	$2 12	131 62
Herman Doering	Rodman	96	3 50 per day	336 00	....	336 00
R. S. Greenman	Rodman	76	3 50 per day	266 00	....	266 00
E. P. Folger	Rodman	173	3 50 per day	605 50	1 71	607 21
Chas. A. Hunt	Rodman	167	3 50 per day	584 50	12 77	597 27
B. E Failing	Rodman	225	3 50 per day	787 50	39 79	827 29
B. S. Fellows	Rodman	155	3 50 per day	542 50	79	543 29
F. E. Holleran	Rodman	48	3 50 per day	168 00	14 24	182 24
G. D. Williams	Rodman	158	3 50 per day	553 00	....	553 00
E. W. Sayles	Rodman	207	3 50 per day	724 50	17 94	742 44
C. E. Cleaver	Rodman	77	3 50 per day	269 50	1 94	271 44
C. K. Munroe	Chainman	51	4 00 per day	204 00	45 61	249 61
C. K. Munroe	Chainman	24	4 50 per day	108 00	23 19	131 19
E. J. Berry	Chainman	94	4 50 per day	423 00	16 33	439 33
L. Kavanagh	Chainman	102	2 50 per day	255 00	....	255 00
D. E. Whitford	Chainman	24	5 00 per day	120 00	8 11	128 11
John Schimmel	Chainman	31	2 50 per day	77 50	....	77 50
Geo H. Thomas	Chainman	225	2 50 per day	562 50	....	562 50
G W. Robinson	Chainman	108	2 50 per day	270 00	....	270 00
T J. Dwyer	Chainman	9	2 50 per day	22 50	....	22 50
C. Hurlbut	Chainman	226	3 50 per day	791 00	3 92	794 92
Louis Meyer	Chainman	225	2 50 per day	562 50	....	562 50
John Phillips	Chainman	167	2 50 per day	417 50	....	417 50
William Rowlands	Chainman	23	2 50 per day	57 50	....	57 50
C. H. Fanning	Chainman	97	2 50 per day	242 50	2 02	244 52
S. L. Adcook	Chainman	166	2 50 per day	415 00	1 94	416 94
J. G. Sweeney	Chainman	180	2 50 per day	450 00	2 02	452 02
Chas. D. Brand	Chainman	141	2 50 per day	352 50	....	352 50
H. C. Titus	Chainman	138	2 50 per day	345 00	26 32	371 32
T. R. Temple	Chainman	51	2 50 per day	127 50	....	127 50
J. J. Schmid	Chainman	86	2 50 per day	215 00	1 50	216 50
D. D. N Marvin	Chainman	178	2 50 per day	445 00	....	445 00
B. E. Turnbull	Chainman	65	2 50 per day	162 50	2 16	164 66
C. A. Cockroft	Chainman	74	4 50 per day	333 00	51 48	384 48
Wm. H. King	Chainman	90	2 50 per day	225 00	....	225 00

Charles Kiehm	Chainman	199	2 50 per day	497 50	....	497 50
F. E. Paddock	Chainman	226	2 50 per day	565 00	....	565 00
John Hackett	Chainman	200	2 50 per day	500 00	45 86	545 86
George M. Harrer	Chainman	167	2 50 per day	417 50	2 94	420 44
Lester Betts	Chainman	78	2 50 per day	195 00	1 94	196 94
E. P. Lincoln	Chainman	36	2 50 per day	90 00	....	90 00
						$35,946 87

Incidental expenses.

Labor	$7,786 50	
Stationery	546 90	
Fuel	22 48	
Light	21 48	
Office rent	302 60	
Postage and telegraph	208 28	
Miscellaneous	4,008 80	
		12,896 92
		$48,843 79

Improvement of the Oswego Canal.

Chapter 79, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$275 04	$35 19	$310 23
George A. Morris	Resident engineer	....	2,000 00 per year	147 58	35 08	182 66
A. C. Driscoll	First assistant engineer	55	6 00 per day	330 00	81 68	411 68
John C. Wait	Assistant engineer	83	5 00 per day	415 00	241 04	656 04
Henry C. Allen	Assistant engineer	120	5 00 per day	600 00	447 70	1,047 70
Reeves Smith	Assistant engineer	107	5 00 per day	535 00	200 15	735 15
Edwin Styring	Leveler	9	4 50 per day	40 50	......	40 50
S. J. Steward	Leveler	16	4 50 per day	72 00	9 00	81 00
William N. Taintor	Leveler	182	4 50 per day	819 00	128 19	947 19
E. H. Thomes	Leveler	124	4 50 per day	558 00	....	558 00
E. A. Lamb	Leveler	26	4 50 per day	117 00	....	117 00
W. J. Town	Leveler	200	4 50 yer day	900 00	2 28	902 28
C. E. Hopkins	Leveler	226	4 50 per day	1,017 00	....	1,017 00
James G. Tracy	Leveler	54	4 50 per day	243 00	....	243 00
John K. Lloyd	Draughtsman	14	4 50 per day	63 00	....	63 00
Fred. J. Wagner	Rodman	2	3 50 per day	7 00	....	7 00
M. S. Smith	Rodman	4	3 50 per day	14 00	....	14 00
W. C. Farrington	Rodman	74	3 50 per day	259 00	....	259 00
C. A. Young	Rodman	124	3 50 per day	434 00	....	434 00
F. B. McLean	Rodman	120	3 50 per day	420 00	....	420 00
L. W. Hall	Rodman	226	3 50 per day	791 00	....	791 00
E. P. Folger	Rodman	54	3 50 per day	189 00	1 78	190 78
C. K. Munroe	Chainman	20	4 00 per day	80 00	8 45	88 45
C. K. Munroe	Chainman	12	4 50 per day	54 00	4 60	58 60
D. E. Whitford	Chainman	3	5 00 per day	15 00	....	15 00
Edmund Adams	Chainman	77	2 50 per day	192 50	....	192 50
R. D. Russell	Chainman	77	2 50 per day	192 50	....	192 50
E. C. Parsons	Chainman	124	2 50 per day	310 00	....	310 00
E. P. Lincoln	Chainman	130	2 50 per day	325 00	....	325 00
Charles Kiehm	Chainman	26	2 50 per day	65 00	....	65 00
E. S. Merritt	Chainman	225	2 50 per day	562 50	....	562 50
Alfred P. Mead, Jr.	Chainman	225	2 50 per day	562 50	....	563 50
H. C. Morton	Chainman	225	2 50 per day	562 50	....	562 50
						$12,362 76

Incidental expenses.

Labor	$1,844 45	
Stationery	62 99	
Fuel	5 76	
Light	13 50	
Office rent	37 50	
Postage and telegraph	22 60	
Miscellaneous	1,209 98	
		3,196 82
		$15,559 58

Ordinary Repairs — Erie Canal.

Chapter 297, Laws of 1894, and Chapter 282, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$426 75	$27 36	$454 11
George A. Morris	Resident engineer	....	2,000 00 per year	321 87	79 21	400 58
A. C. Driscoll	First assistant engineer	5	6 00 per day	30 00	10 92	40 92
Reeves Smith	Assistant engineer	2	5 00 per day	10 00	....	10 00
Edwin Styring	Leveler	4	4 50 per day	18 00	....	18 00
Paul L. Schultz	Leveler	49	4 50 per day	220 50	30 00	250 50
E. A. Lamb	Leveler	6	4 50 per day	27 00	11 92	38 92
John K. Lloyd	Draughtsman	1	4 50 per day	4 50	....	4 50
L. K. Devendorf	Rodman	67	3 50 per day	234 50	6 59	241 09
C. K. Munroe	Chainman	65	4 00 per day	260 00	98	260 98
C. K. Munroe	Chainman	16	4 50 per day	72 00	....	72 00
B. F. Bauder	Chainman	9	4 00 per day	36 00	1 00	37 00
E. J. Berry	Chainman	2	3 50 per day	7 00	15 59	22 59
L. Kavanaugh	Chainman	2	2 50 per day	5 00	6 59	11 59
D. E. Witford	Chainman	39	5 00 per day	195 00	25 40	220 40
C. A. Cockroft	Chainman	14	4 50 per day	63 00	....	63 00
John Hackett	Chainman	41	2 50 per day	102 50	....	102 50
John Schimmel	Chainman	46	2 50 per day	115 00	4 30	119 30
G. W. Robinson	Chainman	31	2 50 per day	77 50	....	77 50
						$2,445 48
Incidental expenses.						
Stationery					$266 05	
Fuel					54 30	
Light					38 16	
Office rent					21 00	
Postage and telegraph					192 63	
Miscellaneous					2,212 56	
						2,784 70
						$5,230 18

Ordinary Repairs — Oswego Canal.

Chapter 282, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$124 78	....	$124 78
George A. Morris	Resident engineer	....	2,000 00 per year	153 16	$2 70	155 86
A. C. Driscoll	First assistant engineer	2	6 00 per day	12 00	13 82	25 82
L. K. Devendorf	Rodman	3	3 50 per day	10 50	....	10 50
C. K. Munroe	Chainman	24	4 00 per day	96 00	....	96 00
C. K. Munroe	Chainman	9	4 50 per day	40 50	....	40 50
B. F. Bauder	Chainman	11	4 00 per day	44 00	17 54	61 54
G. W. Robinson	Chainman	14	2 50 per day	35 00	11 14	46 14
						$561 14
Incidental expenses.						
Labor					$3 00	
Miscellaneous					9 95	
						12 95
						$574 09

Ordinary Repairs — Black River Canal.

Chapter 282, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$78 87	....	$78 87
George A. Morris	Resident engineer	....	2,000 00 per year	153 15	$106 34	259 49
A. C. Driscoll	First assistant engineer	6	6 00 per day	36 00	17 72	53 72
Edwin Styring	Leveler	6	4 50 per day	27 00	7 46	34 46
John K Lloyd	Draughtsman	2	4 50 per day	9 00	....	9 00
C. K. Kunroe	Chainman	24	4 00 per day	96 00	....	96 00
C. K. Munroe	Chainman	9	4 50 per day	40 50	....	40 50
						$572 04
Incidental expenses.						
Postage and telegraph					$4 42	
Miscellaneous					2 50	
						6 92
						$578 96

Ordinary Repairs — Cayuga and Seneca Canal.

Chapter 282, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$78 87	....	$78 87
George A. Morris	Resident engineer	....	2,000 00 per year	92 93	$19 54	112 47
Edwin Styring	Leveler	2	4 50 per day	9 00	....	9 00
E. A. Lamb	Leveler	3	4 50 per day	13 50	....	13 50
Arthur O'Brien	Leveler	20	4 50 per day	90 00	3 30	93 30
John K. Lloyd	Draughtsman	1	4 50 per day	4 50	....	4 50
C. K. Munroe	Chainman	24	4 50 per day	96 00	....	96 00
C. K. Munroe	Chainman	9	4 50 per day	40 50	....	40 50
B. F. Bauder	Chainman	9	4 00 per day	36 00	21 52	57 52
D. E. Whitford	Chainman	17	5 00 per day	85 00	13 25	98 25
						$603 91
Incidental expenses.						
Postage and telegraph					$1 23	
Miscellaneous					2 55	
						3 78
						$607 69

Repairs to Owasco Lake Outlet.

Chapter 99, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$26 22	$9 33	$35 55
George A Morris	Resident engineer	....	2,000 00 per year	76 57	60 10	136 67
W. W Jeffers	Assistant engineer	91	5 00 per day	455 00	25 61	480 61
Noble E. Whitford	Leveler	10	4 50 per day	45 00	....	45 00
John K. Lloyd	Draughtsman	4	4 50 per day	18 00	....	18 00
Fred J. Wagner	Rodman	94	4 50 per day	423 00	32 48	455 48
J. J. Schmid	Chainman	100	2 50 per day	250 00	144 84	394 84
William Rowlands	Chainman	6	2 50 per day	15 00	15 23	30 23
						$1,596 38
Incidental expenses.						
Labor					$24 75	
Postage and telegraph					2 43	
Office rent					20 00	
Miscellaneous					76 83	
						124 01
						$1,720 39

Genesee Street Bridge at Utica.

Chapter 170, *Laws of* 1895.

INCIDENTAL EXPENSES.

Miscellaneous	$150 00

Vertical Wall at Higginsville.

Chapter 299, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Paul L. Schultze	Leveler	16	$4 50 per day	$72 00	$72 43	$144 43
John Hackett	Chainman	3	2 50 per day	7 50	4 86	12 36
C. A. Cockroft	Chainman	1	4 50 per day	4 50	2 54	7 04
John Schimmel	Chainman	13	2 50 per day	32 50	22 16	54 66
						$218 49
Incidental expenses.						
Postage and telegraph					$2 90	
Miscellaneous					6 47	
						9 37
						$227 86

Lift Bridge at Genesee Street, Syracuse.

***Chapter* 311, *Laws of* 1895.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$19 67	....	$19 67
A. C. Driscoll	First assistant engineer	4	6 00 per day	24 00	....	24 00
L. K. Devendorf	Rodman	2	3 50 per day	7 00	....	7 00
						$50 67
Incidental expenses.						
Miscellaneous					$948 60	948 60
						$990 27

Improving Cowasselon Creek.

Chapter 366, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$13 15	$6 85	$20 00
George A. Morris	Resident engineer	....	2,000 00 per year	5 48	1 84	7 32
A. C. Driscoll	First assistant engineer	12	6 00 per day	72 00	18 23	90 23
Edwin Styring	Leveler	1	4 50 per day	4 50	....	4 50
L. K. Devendorf	Rodman	95	3 50 per day	332 50	10 21	342 71
E. J. Berry	Chainman	82	3 50 per day	287 00	15 01	302 01
E. J. Berry	Chainman	83	4 50 per day	373 50	29 75	403 25
Wm. Rowlands	Chainman	126	2 50 per day	315 00	15 36	330 36
L. Kavanaugh	Chainman	164	2 50 per day	410 00	71 87	481 87
						$1,982 25
Incidental expenses.						
Office rent					$5 25	
Postage and telegraph					1 10	
Miscellaneous					261 18	
						267 53
						$2,249 78

Vertical Wall at Clay Street, Utica.

Chapter 367, *Laws of* 1895.

NAME.	Rank.	Number of days	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$10 94	$5 32	$16 26
Paul L. Schultze	Leveler	17	4 50 per day	76 50	1 78	78 28
John Hackett	Chainman	4	2 50 per day	10 00	30	10 30
C. A. Cockroft	Chainman	1	4 50 per day	4 50	3 28	7 78
John Schimmel	Chainman	25	2 50 per day	62 50	20	62 70
						$175 32
Incidental expenses.						
Light					$0 66	
Postage and telegraph					2 77	
Miscellaneous					7 47	
						10 90
						$186 22

Otisco Lake Inlet Bridge.

***Chapter* 497, *Laws of* 1895.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$39 45	$5 00	$44 45
George A. Morris	Resident engineer	....	2,000 00 per year	16 40	23 50	39 90
A. C. Driscoll	First assistant engineer	17	6 00 per day	102 00	34 25	136 25
Edwin Styring	Leveler	1	4 50 per day	4 50	1 00	5 50
Paul L. Schultze	Leveler	1	4 50 per day	4 50	4 66	9 16
John K. Lloyd	Draughtsman	3	4 50 per day	13 50	....	13 50
Fred J. Wagner	Rodman	4	4 50 per day	18 00	5 50	23 50
C. K. Munroe	Chainman	1	4 00 per day	4 00	2 55	6 55
B. F Bauder	Chainman	3	4 00 per day	12 00	4 50	16 50
Jay Capron	Chainman	26	5 00 per day	130 00	2 28	132 28
D. E. Whitford	Chainman	3	5 00 per day	15 00	....	15 00
John Hackett	Chainman	1	2 50 per day	2 50	4 08	6 58
C. A. Cockroft	Chainman	67	4 50 per day	301 50	20 16	321 66
						$770 83
Incidental expenses.						
Postage and telegraph					$1 25	
Miscellaneous					16 25	
						17 50
						$788 33

Cleaning Lake Brook Ditch.

Chapter 672, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$6 57	$0 92	$7 49
A. C. Driscoll	First assistant engineer	2	6 00 per day	12 00	8 00	20 00
Edwin Styring	Leveler	1	4 50 per day	4 50	50	5 00
Paul L. Schultze	Leveler	7	4 50 per day	31 50	25 72	57 22
						$89 71
Incidental expenses.						
Postage and telegraph					$0 69	
Miscellaneous					20	
						89
						$90 60

Cleaning Manlius Ditch.

Chapter 851, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
E. J. Berry	Chainman	1	$3 50 per day	$2 50	$1 94	$5 44
William Rowlands	Chainman	4	2 50 per day	10 00	5 01	15 01
Total						$20 45

Cleaning Ditch, Town of Elbridge.

Chapter 932, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	First assistant engineer	3	$6 00 per day	$18 00	$8 35	$26 35
Paul L. Schultze	Leveler	1	4 50 per day	4 50	2 68	7 18
E. A. Lamb	Leveler	7	4 50 per day	31 50	5 36	36 86
William Rowland	Chainman	1	2 50 per day	2 50	2 19	4 69
L. Kavanaugh	Chainman	1	2 50 per day	2 50	2 18	4 68
John Hackett	Chainman	1	2 50 per day	2 50	2 68	5 18
						$86 94
Incidental expenses.						
Postage and telegraph					$4 30	
Miscellaneous					1 00	
						5 30
						$90 24

Gilbert Street Wall at Utica.

Chapter 968, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$5 46	$3 16	$8 62
Paul L. Schultze	Leveler	59	4 50 per day	265 50	15 60	281 10
John Hackett	Chainman	31	2 50 per day	77 50	1 90	79 40
C. A. Cockroft	Chainman	1	4 50 per day	4 50	2 83	7 33
John Schimmel	Chainman	41	2 50 per day	102 50	4 40	106 90
						$483 35
Incidental expenses.						
Stationery					$1 00	
Office rent					7 00	
Postage and telegraph					1 00	
Miscellaneous					3 15	
						12 15
						$495 50

Canaseraga Creek Culvert.

Chapter 969, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	First assistant engineer	7	$6 00 per day	$42 00	$23 93	$65 93
Paul L. Schultze	Leveler	7	4 50 per day	31 50	12 74	44 24
E. J. Berry	Chainman	2	3 50 per day	7 00	1 00	8 00
John Hackett	Chainman	10	2 50 per day	25 00	19 28	44 28
						$162 45
Incidental expenses.						
Postage and telegraph					$0 50	
Miscellaneous					7 10	
						7 60
						$170 05

Improving Channel Butternut Creek.

Chapter 119, *Laws of* 1893, *and chapter* 1009, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	First assistant engineer	6	$6 00 per day	$36 00	$15 25	$51 25
Edwin Styring	Leveler	2	4 50 per day	9 00	....	9 00
Paul L. Schultze	Leveler	1	4 50 per day	4 50	2 08	6 58
George C. Diehl	Leveler	2	4 50 per day	9 00	1 00	10 00
Fred J. Wagner	Rodman	1	3 50 per day	3 50	1 00	4 50
Fred J. Wagner	Rodman	1	4 50 per day	4 50	4 25	8 75
						$90 08
Incidental expenses.						
Postage and telegraph					$4 24	
Miscellaneous					2 00	
						6 24
						$96 32

Cleaning Ditch at Port Byron.

Chapter 950, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. E. Raynor	Assistant engineer	7	$5 00 per day	$35 00	$20 00	$55 00
James G. Tracy	Leveler	2	4 50 per day	9 00	....	9 00
E. W. Sayles	Rodman	6	3 50 per day	21 00	....	21 00
John Hackett	Chainman	6	2 50 per day	15 00	....	15 00
E. P. Lincoln	Chainman	4	2 50 per day	10 00	....	10 00
						$110 00
Incidental expenses.						
Labor					$6 00	
Miscellaneous					4 00	
						10 00
						$120 00

Stone Dam at Baldwinsville.

Chapter 113, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$6 57	$0 70	$7 27
George A. Morris	Resident engineer	....	2,000 00 per year	54 79	....	54 79
Paul L. Schultze	Leveler	22	4 50 per day	99 00	2 66	101 66
C. K. Munroe	Chainman	27	4 00 per day	108 00	....	108 00
L Kavanagh	Chainman	3	2 50 per day	7 50	....	7 50
John Schimmel	Chainman	27	2 50 per day	67 50	....	67 50
						$346 72
Incidental expenses.						
Postage and telegraph					$0 50	
Miscellaneous					50 00	
						50 50
						$397 22

Improving Oswego Canal.

***Chapter* 219, *Laws of* 1895.**

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A C. Driscoll	First assistant engineer	1	$6 00 per day	$6 00	$2 75	$8 75
George C. Diehl	Leveler	1	4 50 per day	4 50	2 90	7 40
						$16 15
Incidental expenses.						
Miscellaneous					$0 25	25
						$16 40

Steel apron to Braddock's Dam.

Chapter 572, Laws of 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$59 17	$9 50	$68 67
George A. Morris	Resident engineer	....	2,000 00 per year	10.96	6 00	16 96
A. C. Driscoll	First assistant engineer	9	6 00 per day	54 00	5 40	59 40
Fred J. Wagner	Rodman	113	3 50 per day	395 00	24 70	420 20
L. K. Devendorf	Rodman	8	3 50 per day	28 00	....	28 00
C. K. Munroe	Chainman	1	4 00 per day	4 00	1 15	5 15
						$598 38
Incidental expenses.						
Postage and telegraph					$2 50	
Miscellaneous					49 85	
						52 35
						$650 73

Stone apron to Oswego Dam.

Chapter 572, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$10 96	$5 80	$16 76
Edwin Styring	Leveler	36	4 50 per day	162 00	8 40	170 40
John K. Lloyd	Draughtsman	3	4 50 per day	13 50	....	13 50
Jay Capron	Chainman	6	5 00 per day	30 00	1 48	31 48
						$232 14
Incidental expenses.						
Office rent					$2 00	
Postage and telegraph					40	
Miscellaneous					1 00	
						3 40
						$235 54

River Bridge at Carthage.

Chapter 102, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$45 88	$23 87	$69 75
George A. Morris	Resident engineer	....	2,000 00 per year	32 79	37 37	70 16
A. C. Driscoll	First assistant engineer	11	6 00 per day	66 00	25 99	91 99
John K. Lloyd	Draughtsman	7	4 50 per day	31 50	....	31 50
L. K Devendorf	Rodman	2	3 50 per day	7 00	....	7 00
E. J. Berry	Chainman	47	4 50 per day	211 50	76 80	288 30
George M. Harrer	Chainman	32	2 50 per day	80 00	3 25	83 25
						$641 95
Incidental expenses.						
Light					$0 48	
Office rent					15 00	
Postage and telegraph					2 33	
Miscellaneous					1,198 01	
						$1,215 82
						$1,857 77

Repairs to North Branch Reservoir.

Chapter 148, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$13 11	$0 25	$13 36
George A. Morris	Resident engineer	....	2,000 00 per year	164 09	313 77	477 86
A. C. Driscoll	First assistant engineer	20	6 00 per day	120 00	68 99	188 99
John C. Wait	Assistant engineer	99	5 00 per day	495 00	147 78	642 78
John K. Lloyd	Draughtsman	11	4 50 per day	49 50	....	49 50
Arthur O'Brien	Rodman	101	3 50 per day	353 50	22 55	376 05
Fred J. Wagner	Rodman	6	3 50 per day	21 00	....	21 00
L. K. Devendorf	Rodman	21	3 50 per day	73 50	....	73 50
C. Hurlbut	Chainman	52	2 50 per day	130 00	57 02	187 02
D. E. Whitford	Chainman	54	5 00 per day	270 00	18 12	288 12
						$2,318 18
Incidental expenses.						
Labor					$230 25	
Stationery					4 98	
Light					1 47	
Postage and telegraph					7 28	
Miscellaneous					179 31	
						423 29
						$2,741 47

Surveys on Account Attorney-General.

Chapter 932, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$21 86	$27 59	$49 45
A. C. Driscoll	First assistant engineer	11	6 00 per day	66 00	26 70	92 70
Edwin Styring	Leveler	3	4 50 per day	13 50	....	13 50
Arthur O'Brien	Leveler	6	4 50 per day	27 00	18 29	45 29
D. E. Whitford	Chainman	18	5 00 per day	90 00	23 08	113 08
						$314 02
Incidental expenses.						
Postage and telegraph					$2 61	2 61
						$316 63

Garden Street Bridge at Rome.

Chapter 965, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$13 11	....	$13 11
George A. Morris	Resident engineer	....	2,000 00 per year	32 81	$24 36	57 17
A. C. Driscoll	First assistant engineer	20	6 00 per day	120 00	28 02	148 02
George C. Diebl	Leveler	2	4 50 per day	9 00	2 06	11 06
John K Lloyd	Draughtsman	3	4 50 per day	13 50	....	13 50
L. K. Devendorf	Rodman	5	3 50 per day	17 50	....	17 50
Jay Capron	Chainman	31	5 00 per day	155 00	....	155 00
						$415 36
Incidental expenses.						
Postage and telegraph					$1 77	
Miscellaneous					188 33	
						190 10
						$605 46

Thomas Street Bridge at Rome.

Chapter 970, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$27 34	$23 30	$50 64
A. C. Driscoll	First assistant engineer	4	6 00 per day	24 00	5 12	29 12
E. A. Lamb	Leveler	2	4 50 per day	9 00	....	9 00
John K. Lloyd	Draughtsman	1	4 50 per day	4 50	....	4 50
Jay Capron	Chainman	51	5 00 per day	255 00	....	255 00
D. E. Whitford	Chainman	5	5 00 per day	25 00	....	25 00
						$373 26
Incidental expenses.						
Postage and telegraph					$2 30	
Miscellaneous					216 44	
						218 74
						$592 00

Rebuilding Locks — Black River Canal.

Chapter 1030, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$32 78	$5 01	$37 79
George A. Morris	Resident enigneer	....	2,000 00 per year	92 91	118 65	211 56
Edwin Styring	Leveler	226	4 50 per day	1,017 00	160 36	1,177 36
John K. Lloyd	Draughtsman	1	4 50 per day	4 50	....	4 50
L. K. Devendorf	Rodman	29	3 50 per day	101 50	10 01	111 51
B. F. Bauder	Chainman	4	4 00 per day	16 00	18 16	34 16
William Rowlands	Chainman	144	2 50 per day	360 00	10 92	370 92
Chauncy Hurlbut	Chainman	29	2 50 per day	72 50	25 43	97 93
Chauncy Hurlbut	Chainman	7	3 50 per day	24 50	4 75	29 25
D. E. Whitford	Chainman	4	5 00 per day	20 00	....	20 00
C. A. Cockroft	Chainman	2	4 50 per day	9 00	7 66	16 66
						$2,111 64
Incidental expenses.						
Office rent					$28 83	
Postage and telegraph					4 55	
Miscellaneous					16 90	
						50 28
						$2,161 92

Rebuilding Lock No. 49 — Black River Canal.

Chapter 947, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Edwin Styring	Leveler	7	$4 50 per day	$31 50	$3 81	$35 81
Incidental expenses.						
Miscellaneous					$4 00	4 00
						$39 81

Repairs to Highway at Cayuga.

Chapter 82, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$6 56	....	$6 56
Incidental expenses.						
Postage and telegraph					$2 05	2 05
						$8 61

Protecting Cayuga and Seneca Canal at Geneva.

Chapter 142, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$65 63	$23 75	$89 38
George A. Morris	Resident engineer	....	2,000 00 per year	21 85	34 54	56 39
Arthur O'Brien	Leveler	31	4 50 per day	139 50	30	139 80
E. A. Lamb	Rodman	39	3 50 per day	136 50	3 08	139 58
Jay Capron	Chainman	99	5 00 per day	495 00	7 70	502 70
D E. Whitford	Chainman	35	5 00 per day	175 00	14 33	189 33
G. W. Robinson	Chainman	4	2 50 per day	10 00	7 06	17 06
						$1,134 24
Incidental expenses.						
Postage and telegraph					$2 61	
Miscellaneous					19 77	
						22 38
						$1,156 62

Improving Cayuga and Seneca Canal and Seneca Lake Outlet.

Chapter 308, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$6 56	$2 58	$9 14
George A. Morris	Resident engineer	....	2,000 00 per year	82 02	92 70	174 72
A. C. Driscoll	First assistant engineer	3	6 00 per day	18 00	10 80	28 80
George C. Diehl	Leveler	2	4 50 per day	9 00	5 04	14 04
E. A. Lamb	Leveler	3	4 50 per day	13 50	2 96	16 46
Arthur O'Brien	Leveler	69	4 50 per day	310 50	6 24	316 74
Noble E. Whitford	Leveler	2	4 50 per day	9 00	....	9 00
John K. Lloyd	Draughtsman	1	4 50 per day	4 50	....	4 50
E. A. Lamb	Rodman	48	3 50 per day	168 00	3 12	171 12
Jay Capron	Chainman	67	5 00 per day	335 00	4 98	339 98
D. E. Whitford	Chainman	89	5 00 per day	445 00	33 55	478 55
						$1,563 05
Incidental expenses.						
Postage and telegraph					$3 96	
Miscellaneous					7 25	11 21
						$1,574 26

Improving Cayuga and Seneca Canal at Seneca Falls

Chapter 512, Laws of 1897

NAME.	Rank	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$39 37	$4 10	$43 47
George A. Morris	Resident engineer	....	2,000 00 per year	21 86	10 48	32 34
A. C. Driscoll	First assistant engineer	2	6 00 per day	12 00	2 68	14 68
L. K. Devendorf	Rodman	15	3 50 per day	52 50	16 06	68 56
B. F. Bauder	Chainman	90	4 00 per day	360 00	35 54	395 54
J. J. Schmid	Chainman	34	2 50 per day	85 00	19 92	104 92
D. E. Whitford	Chainman	12	5 00 per day	60 00	....	60 00
						$719 51
Incidental expenses.						
Light					$0 96	
Office rent					18 00	
Postage and telegraph					3 76	
Miscellaneous					13 00	
						35 72
						$755 23

Improving Cayuga and Seneca Canal at Waterloo.

Chapter 512, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$52 52	$9 60	$62 12
George A. Morris	Resident engineer	....	2,000 00 per year	38 31	25 74	64 05
A. C. Driscoll	First assistant engineer	11	6 00 per day	66 00	4 50	70 50
E. A. Lamb	Leveler	4	4 50 per day	18 00	....	18 00
Arthur O'Brien	Leveler	1	4 50 per day	4 50	80	5 30
John K. Lloyd	Draughtsman	4	4 50 per day	18 00	....	18 00
E. A. Lamb	Rodman	1	3 50 per day	3 50	1 04	4 54
L. K. Devendorf	Rodman	16	3 50 per day	56 00	2 34	58 34
B. F. Bauder	Chainman	121	4 00 per day	484 00	87 64	571 64
J. J. Schmid	Chainman	90	2 50 per day	225 00	99 90	324 90
D. E. Whitford	Chainman	12	5 00 per day	60 00	4 38	64 38
						$1,261 77
Incidental expenses.						
Fuel					$4 13	
Light					1 56	
Office rent					15 00	
Postage and telegraph					8 32	
Miscellaneous					89 75	
						118 76
						$1,380 53

Ditch between Seneca Falls and Waterloo.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. H. H. Gere	Division engineer	....	$2,400 00 per year	$6 56	....	$6 56
A. C. Driscoll	First assistant engineer	1	6 00 per day	6 00	$3 74	9 74
Fred J. Wagner	Rodman	14	4 50 per day	63 00	8 88	71 88
J. J. Schmid	Chainman	4	2 50 per day	10 00	6 88	16 88
B. E. Turnbull	Chainman	3	2 50 per day	7 50	6 88	14 38
						$118 94
Incidental expenses.						
Miscellaneous					$1 60	1 60
						$120 54

Repairing Pier at Head of Cayuga Lake.

Chapter 219, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	First assistant engineer	5	$6 00 per day	$30 00	$5 30	$35 30
Paul L. Schultze	Leveler	1	4 50 per day	4 50	7 14	11 64
Total						$46 94

Highway, Town of Croghan.

Chapter 849, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation	Salary.	Travel.	Total.
George A Morris	Resident engineer	....	$2,000 00 per year	$5 46	$7 00	$12 46
A. C. Driscoll	First assistant engineer	1	6 00 per day	6 00	....	6 00
L. K. Devendorf	Rodman	5	3 50 per day	17 50	....	17 50
E. J. Berry	Chainman	3	4 50 per day	13 50	10 58	24 08
George M. Harrer	Chainman	27	2 50 per day	67 50	....	67 50
						$127 54
Incidental expenses.						
Miscellaneous					$3 25	3 25
						$130 79

Bridge Survey, Foot Cayuga Lake.

Chapter 719, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. C. Driscoll	First assistant engineer	6	$6 00 per day	$36 00	$6 63	$42 63
W. W. Jeffers	Assistant engineer	3	5 00 per day	15 00	7 48	22 48
George C. Diehl	Leveler	8	4 50 per day	36 00	7 48	43 48
John K. Lloyd	Draughtsman	59	4 50 per day	265 50	1 98	267 48
L. K. Devendorf	Rodman	1	3 50 per day	3 50	2 48	5 98
E. J. Berry	Chainman	3	3 50 per day	10 50	7 48	17 98
L. Kavanaugh	Chainman	3	2 50 per day	7 50	7 48	14 98
Jay Capron	Chainman	2	5 00 per day	10 00	2 73	12 73
C. Hurlbut	Chainman	3	3 50 per day	10 50	7 49	17 99
C. A. Cockroft	Chainman	3	4 50 per day	13 50	7 48	20 98
						$466 71
Incidental expenses.						
Labor					$0 50	
Miscellaneous					50	
						1 00
						$467 71

Highway, Onondaga Indian Reservation.

Chapter 932, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$27 34	$21 00	$48 34
Incidental expenses.						
Labor					$19 50	
Miscellaneous					50	
						20 00
						$68 34

Dredging Channel, Lake Ontario to Wigwam Cove.

Chapter 1009, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$27 31	$46 68	$73 99
A. C. Driscoll	First assistant engineer	10	6 00 per day	60 00	25 46	85 46
L. K. Devendorf	Rodman	6	3 50 per day	21 00	8 40	29 40
B. F. Bauder	Chainman	81	4 00 per day	324 00	32 40	356 40
G. W. Robinson	Chainman	49	2 50 per day	122 50	11 95	134 45
						$680 70
Incidental expenses.						
Labor					$5 75	
Postage and telegraph					2 37	
Miscellaneous					51 25	
						$59 37
						$739 0[illegible]

Piling Outlet, Lake Keuka.

Chapter 1009, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$10 96	$9 38	$20 34
A. C. Driscoll	First assistant engineer	5	6 00 per day	30 00	12 96	42 96
George C. Diehl	Leveler	79	4 50 per day	355 50	40 16	395 66
E. A. Lamb	Rodman	1	3 50 per day	3 50	3 00	6 50
						$465 46
Incidental expenses.						
Miscellaneous					$22 50	22 50
						$487 96

36

River Bridge at Glendale.

Chapter 800, *Laws of* 1896.

INCIDENTAL EXPENSES.

Miscellaneous $150 00

Extraordinary Repairs — Middle Division.

Chapter 947, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George A. Morris	Resident engineer	....	$2,000 00 per year	$81 96	$152 00	$233 96
A. C. Driscoll	First assistant engineer	4	6 00 per day	24 00	11 75	35 75
M. B. Palmer	Assistant engineer	26	5 00 per day	130 00	68 91	198 91
C. E. Raynor	Assistant engineer	25	5 00 per day	125 00	59 17	184 17
Edwin Styring	Leveler	29	4 50 per day	130 50	26 98	157 48
Fred W. Sarr	Leveler	45	4 50 per day	202 50	74 87	277 37
E. H. Thomes	Leveler	15	4 50 per day	67 50	....	67 50
John K. Lloyd	Draughtsman	23	4 50 per day	103 50	....	103 50
Fred J. Wagner	Rodman	10	4 50 per day	45 00	16 24	61 24
L. K. Devendorf	Rodman	4	3 50 per day	14 00	9 10	23 10
James Browne, jr	Rodman	4	3 50 per day	14 00	8 97	22 97
M. S. Smith	Rodman	10	3 50 per day	35 00	....	35 00
E. W. Sayles	Rodman	12	3 50 per day	42 00	....	42 00
William Rowlands	Chainman	14	2 50 per day	35 00	42	35 42
L. Kavanagh	Chainman	39	2 50 per day	97 50	36 45	133 95
Chas. D. Brand	Chainman	11	2 50 per day	27 50	....	27 50
J. G. Sweeney	Chainman	6	2 50 per day	15 00	....	15 00
John Hackett	Chainman	14	2 50 per day	35 00	....	35 00
E. P. Lincoln	Chainman	12	2 50 per day	30 00	....	30 00
						$1,719 82
Incidental expenses.						
Labor					$56 50	
Postage and telegraph					6 13	
Miscellaneous					86 25	
						148 88
						$1,868 70

Summary.

ITEMS.	AUTHORIZED BY Chap.	AUTHORIZED BY Year.	Amounts.	Total.
ORDINARY REPAIRS.				
Erie canal	297 282	1894 1895	$5,230 18	
Oswego canal	282	1895	574 09	
Black River canal	282	1895	578 96	
Cayuga and Seneca canal	282	1895	607 69	$6,990 92
EXTRAORDINARY REPAIRS.				
Erie Canal.				
Improvement Erie canal	79	1895	$48,843 79	
Repairs to Owasco Lake outlet	99	1895	1,720 39	
Genesee street bridge at Utica	170	1895	150 00	
Vertical wall at Higginsville	299	1895	227 86	
Lift bridge at Genesee street, Syracuse	311	1895	999 27	
Improving Cowaselon creek	366	1895	2,249 78	
Vertical wall at Clay street, Utica	367	1895	186 22	
Otisco Lake inlet bridge	497	1895	788 33	
Cleaning Lake Brook ditch	678	1895	90 60	
Cleaning Manlius ditch	851	1895	20 45	
Cleaning ditch, town of Elbridge	932	1895	90 24	
Gilbert street wall at Utica	968	1895	495 50	
Canaseraga creek culvert	969	1895	170 05	
Improving channel, Butternut creek	119 1009	1893 1895	96 32	
Cleaning ditch at Port Byron	950	1896	120 00	56,248 80
Oswego Canal.				
Improvement of the Oswego canal	79	1895	$15,559 58	
Stone dam at Baldwinsville	113	1895	397 22	
Improving Oswego canal	219	1895	16 40	
Steel apron to Braddock's dam	572	1894	650 73	
Stone apron to Oswego dam	572	1895	235 54	16,859 47
Black River Canal.				
River bridge at Carthage	102	1895	$1,857 77	
Repairs to North Branch reservoir	148	1895	2,741 47	
Survey on account of Attorney-General	932	1895	316 63	
Garden street bridge at Rome	965	1895	605 46	
Thomas street bridge at Rome	970	1895	592 00	
Rebuilding locks, Black River canal	1030	1895	2,161 92	
Rebuilding lock No. 49, Black River canal	947	1896	39 31	8,314 56
Cayuga and Seneca Canal.				
Repairs to highway at Cayuga	82	1895	$8 61	
Protecting Cayuga and Seneca canal at Geneva	142	1895	1,156 62	
Improving Cayuga and Seneca canal and Seneca Lake outlet	308	1895	1,574 26	
Improving Cayuga and Seneca canal at Seneca Falls	512	1895	755 23	
Improving Cayuga and Seneca canal at Waterloo	512	1895	1,380 53	
Ditch between Seneca Falls and Waterloo	932	1895	120 54	4,995 79
Miscellaneous.				
Repairing pier at head af Cayuga lake	219	1895	$46 94	
Bridge survey, foot Cayuga lake	719	1895	467 71	
Highway, town of Croghan	849	1895	130 79	
Highway, Onondaga Indian reservation	932	1895	68 34	
Dredging channel, Lake Ontario to Wigwam Cove	1009	1895	739 07	
Piling outlet, Lake Keuka	1009	1895	487 96	
River bridge at Glendale	800	1896	150 00	
Extraordinary repairs Middle Division	947	1896	1,868 70	8,959 51
Total abstracts rendered during fiscal year	......	......	....	$97,369 05

TABLE No. 2.

Statement of Contracts in Force September 30, 1896.

NAME OF CONTRACTORS.	Date of contract.	Character of work.	ACT. Chap.	ACT. Year.	Appropriation.	Engineer's estimate.	Engineer's estimate contract prices.	Payment to Sept. 30.
E. H. Fleming & Company	Aug. 6, 1895	Protecting Cayuga and Seneca canal at Geneva.	142	1895	$15,000 00	$15,000 00	$10,948 00	$8,075 00
G. W. Barlow	Aug. 30, 1895	Improving channel Seneca river and Old Bear race, Waterloo	572 512	1894 1895	20,000 00	14,297 50	7,837 00	9,[illegible]88 00
John H. Nelson	Aug 29, 1895	Discharge pipes at North Lake reservoir	148	1895	*25,000 00	17,983 50	16,764 50	12,410 00
E. H. Fleming & Company	Oct. 1, 1895	Improving Cayuga and Seneca canal and Seneca lake outlet	308	1895	20,000 00	13,600 00	10,041 70	6,460 00
Havana Bridge Works	April 21, 1896	Superstructure for bridge over Black River canal at Garden street, Rome	965	1895	† 3,500 00	....	3,184 00	....
Dunfee, Belden, Dwyer & Co.	June 29, 1896	Substructure for bridge over Black river at Carthage	102	1895	25,000 00	5,135 00	4,704 00	3,672 00
Buffalo Bridge & Iron Works	July 2, 1896	Superstructure for bridge over Black river at Carthage	102	1895			15,170 00	6,800 00
Brummelkamp & Lane	July 1, 1896	Substructure for lift-bridge at West Genesee street, Syracuse	311 950	1895 1896	‡12,500 00	10,655 00	9,865 00	....
Hilton Bridge Company	July 3, 1896	Superstructure for lift-bridge at West Genesee street, Syracuse	311 950	1895 1896			9,950 00	....
Havana Bridge Works	July 31, 1896	Changing and reconstructing bridge at Genesee street, Utica	170 950	1895 1896	§ 16,000 00 9,000 00	....	13,187 40	....
Hughes Brothers	Sept. 4, 1896	Continuing construction of bridge and approaches over inlet to Otisco lake.	793	1896	10,000 00	8,912 00	8,318 00	2,431 00

* $25,000 appropriated for this and other work. † An equal amount appropriated by the city of Rome. ‡ An equal amount appropriated by the city of Syracuse. § $8,000 in addition appropriated by the city of Utica.

TABLE No. 3.

Statement of contracts completed and settled during the fiscal year.

NAME OF CONTRACTORS.	Date of contract.	Character of work.	Act. Chap.	Act. Year.	Appropriation.	Engineer's estimate.	Final account.
J. B. Donnelly	Nov. 1, 1894	Stone apron to Oswego dam	572	1894	$30,000 00	$24,185 00	$25,489 59
E. S. Candee	Aug. 2, 1895	Bridge over Otisco lake inlet	497	1895	8,000 00	7,964 00	6,428 15
Willard Johnson	Aug. 3, 1895	Culvert and vertical wall on second level Cayuga and Seneca canal, at Seneca Falls	512	1895	20,000 00	8,230 50	9,704 05
Michael Bennett	Aug. 28, 1895	Road over spillway at North Branch reservoir	148	1895	*25,000 00	3,853 50	5,240 38
E. G. Gay	Aug. 29, 1895	State ditch at Cowaselon swamp	366	1895	30,000 00	21,350 00	27,526 25
J. J. Hallock	Aug. 30, 1895	Repairs Owasco lake outlet	99	1895	12,000 00	12,000 00	10,080 72
John Hannon	Sept. 3, 1895	Opening channel at Wigwam Cove, Lake Ontario	1009	1895	10,000 00	10,000 00	8,541 90
Dodge & McGregor	Sept. 7, 1895	Rebuilding combined locks 39–43 B. R. canal	1030	1895	45,000 00	38,881 50	37,958 24
Hughes Brothers	Sept. 9, 1895	Steel apron to portion of Braddock's dam	572 368	1894 1895	25,000 00	16,475 00	15,024 14
J. J. Dwyer	Sept. 17, 1895	Vertical wall at Turner and Gilbert streets, Utica	968	1895	10,000 00	9,993 50	7,373 28
Brayer, Albaugh, Lauer & Hagaman	Sept. 20, 1895	Vertical wall at Higginsville	299	1895	2,500 00	2,399 00	1,923 01
Brayer, Albaugh, Lauer & Hagaman	Sept. 20, 1895	Vertical wall at Clay street, Utica	367	1895	2,500 00	2,499 50	2,019 37
Brayer, Albaugh, Lauer & Hagaman	Sept. 20, 1895	Piling outlet Lake Keuka	1009	1895	8,500 00	8,414 00	6,655 99
Owego Bridge Co.	Mar. 10, 1896	Superstructure road and tow-path bridge at Seneca Falls	947	1896	....	1,550 00	1,550 00
King Bridge Co.	Apr. 20, 1896	Superstructure for Thomas street bridge at Rome	970	1895	7,000 00	2,500 00	1,930 00
F. L. Faass & Co.	Apr. 20, 1896	Substructure for Thomas street bridge at Rome	970	1895		3,426 00	3,518 90
Brummelkamp & Lane	Apr. 23, 1896	Substructure for Garden street bridge at Rome	965	1895	†3,500 00	2,190 00	2,689 36
Total	....	....	......	......	....	....	$173,653 33

* $25,000 appropriated for this and other work.

† An equal sum appropriated by the city of Rome.

TABLE No. 4.

Water Record of Cayuga and Cross Lakes and Seneca River, Continued.

See State Engineer and Surveyor's Report of 1895 for previous records.

LOCATION.	1895.		1896.				
	December 9 and 10.		March 6, 7 and 9.		August 5 and 7.		
	Water.		Water.		Water.		
	Surface.	Depth.	Surface.	Depth.	Surface.	Depth.	
Cayuga lake	—10.37	8.70	— 7.83	11.25	— 8.58	10.60	Depth on lock mitre-sill.
Mud lock	—10.25	8.97	— 8.02	11.20	— 8 68	10.48	Depth on lock mitre-sill.
Canandaigua river, south of canal	—13.04	4.20	— 8 22	8 00	—11.78	4.40	Depth of river.
Aqueduct	—13.44	5.00	— 8 56	9.80	—12.49	5 91	Depth on aqueduct foundation.
Canandaigua river, north of canal	—13.38	4.30	— 8 64	9.00	—12.58	5.00	Depth of river.
West Shore railroad crossing	—13 40	2.20	— 9.34	6.00	—12.87	3.73	Depth on natural bed.
				11.00		8.73	Depth in channel, dredged.
New York Central and Hudson River Railroad	—14.27	3.00	— 9.57	7.70	—13.04	4.48	Depth on bridge foundation.
Mosquito Point	—16 42	Dry.	—10.48	5.50	—15.47	0.41	Depth on natural bed.
		6.50		12.60		6.25	Depth in channel, dredged.
Cross Lake	—17.68	18.8	—12.02	24.5	—17.10	18.47	Depth at iron bridge.

APPENDIX VI.

REPORT

OF THE

DIVISION ENGINEER

OF THE

WESTERN DIVISION

FOR THE

Year Ending September 30, 1896.

REPORT

ROCHESTER, *February* 6, 1897.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

SIR.— I have the honor of submitting to you my report on the western division of the State canals for the fiscal year ending September 30, 1896.

The canal slips and navigable feeders are as follows:

	Miles.
Erie canal from the east line of Wayne county to Hamburg street, in the city of Buffalo	148.92
Five slips in the city of Buffalo, aggregate length	1.60
Genesee river feeder, in the city of Rochester	2.25
Total	152.77

UNNAVIGABLE FEEDERS.

Tonawanda and Oak Orchard	11.55
Genesee Valley canal, from Cuba reservoir to lock 87, Rockville	7.65
Genesee Valley canal, from Scottsville to Rochester rapids dam	11.00
Total	30.20

The resources of water supply for the Erie canal are as follows:

1. Lake Erie, at Buffalo.
2. Tonawanda creek, at Pendleton.
3. Tonawanda and Oak Orchard creek, at Medina.
4. Allen's creek, through the Genesee Valley canal and Genesee river feeder, from Scottsville to Rochester. This water is con-

nected from the Genesee Valley canal by pipe across the Genesee river to the feeder below the rapids dam, and thence into the canal.

5. The Cuba reservoir in Allegany county, through the Genesee Valley canal and the Genesee river to Rochester, and through the Genesee river feeder, in the city of Rochester, into the canal. The Tonawanda and Oak Orchard feeder and the Genesee river assist in filling the canal in the spring. The water from Allen's creek, at Scottsville, which is taken into the feeder at Rochester, tends to keep the water in the feeder pure during the summer months.

DAMS.

There are six dams on the division, as follows:

1. One across Tonawanda creek, near its mouth. It raises the waters in the creek about four feet above the level of the Niagara river.

2. One across the same creek, south of Medina. Its purpose is to turn the waters of the creek into the feeder, and through it into the channel of Oak Orchard creek, and thence into the canal at Medina.

3. One across Allen's creek, in the village of Scottsville, to send the water through the Genesee Valley canal, which is now used as a feeder from Scottsville to Rochester.

4. One across the Genesee river at Rochester to turn the water of the stream into the feeder.

5. One across Oil creek, near the village of Cuba, Allegany county, to hold the waters of that creek and form a reservoir. It is composed of earth faced with rip-rap and slope wall, and is 2,200 feet long and 65 feet in height where it crosses the stream.

6. One across a valley two miles from the last-mentioned one. It has a waste-weir, composed of stone, to serve as an escape for the waters of the creek when the reservoir is full.

LOCKS.

There are twenty-three locks on this division, and all lock down toward tide water.

No.	Location.	Lift in feet.
53.	One and one-fourth miles west of Clyde (lengthened)..	4.755
54.	At Lock Berlin (lengthened)......................	7.360

No.	Location.	Lift in feet.
55.	In the village of Lyons (lengthened)................	6.251
56.	Poorhouse, one and seven-tenths miles west of Lyons (lengthened)..	9.848
57.	Lower lock at Lockville, near Newark (not lengthened)..	8.028
58.	Middle lock at Lockville, near Newark (not lengthened)..	8.004
59.	Upper lock at Lockville, near Newark (not lengthened)..	8.002
60.	Eight-tenths of a mile east of Macedon (lengthened)..	9.886
61.	In the village of Macedon (lengthened)..............	6.601
62.	Two and one-quarter miles west of Pittsford (lengthened)..	8.807
63.	Miller's lock, in the village of Brighton (lengthened)..	8.719
64.	Sipple's lock, in the village of Brighton (lengthened)..	10.108
65.	Reservior lock in the city of Rochester (lengthened)...	10.102
66.	First lock in the city of Rochester (lengthened)......	8.859
67-71.	Five combined locks at Lockport (not lengthened).	57.427
	One guard lock at Sulphur Springs. It has one chamber 110 x 20 feet and two additional head-gates. These gates are closed when a flood occurs in Tonawanda creek; otherwise they are left open.	
	One river lock at Tonawanda, connecting the Niagara river with canal. The lift is generally four feet, depending on the height of water in river.	
	One double chamber guard and lift lock (lengthened), at Black Rock (No. 72). It is 112x20 feet. The lift together with the fall in the harbor from the canal below the mean low waters in the lake is...........	2.425
	Total..	175.182

By adding to the above lifts the surface descent on the different levels we get the total descent on the division:

On Montezuma level...........................	.196
On Twelve-mile level, Nos. 59 to 60..............	.165
On Seventeen-mile level, Nos. 61 to 62............	.343

On Three-mile level, Nos. 62 to 63	.063	
On long level, Rochester to Lockport, Nos. 66 to 67.	3.165	
On level between Lockport and Black Rock	1.239	
		5.171
Total rise going west		180.353

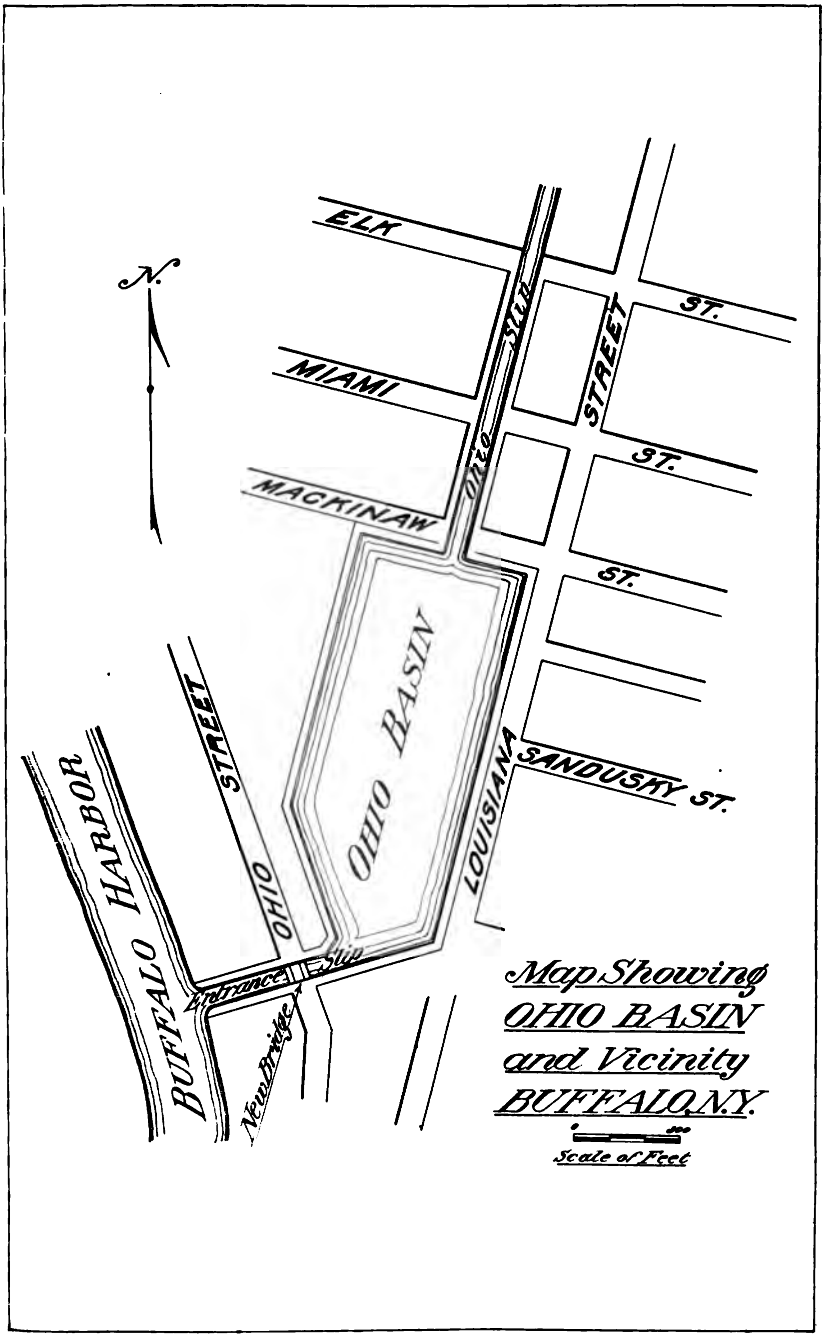
There is also one single chamber ship lock from Black Rock harbor to Niagara river. It is 200 x 36 feet. The lift is usually four feet, depending on the height of water in lake and river. The weigh-lock, in the city of Rochester, has not been used as such for some years.

Nearly all of the locks on the division need repairing. In most cases they can be put in fair shape if the masonry joints were scraped out and repointed with Portland cement. This work will probably be done, as recommended, later, under the description of the work to be done under act, chapter 79, Laws of 1896. As a great portion of the needed repairs to the canal structures will have to be done under the reading of this law, I shall at present make mention only of repairs needed to structures, the cost of which should come under some other source.

BRIDGES.

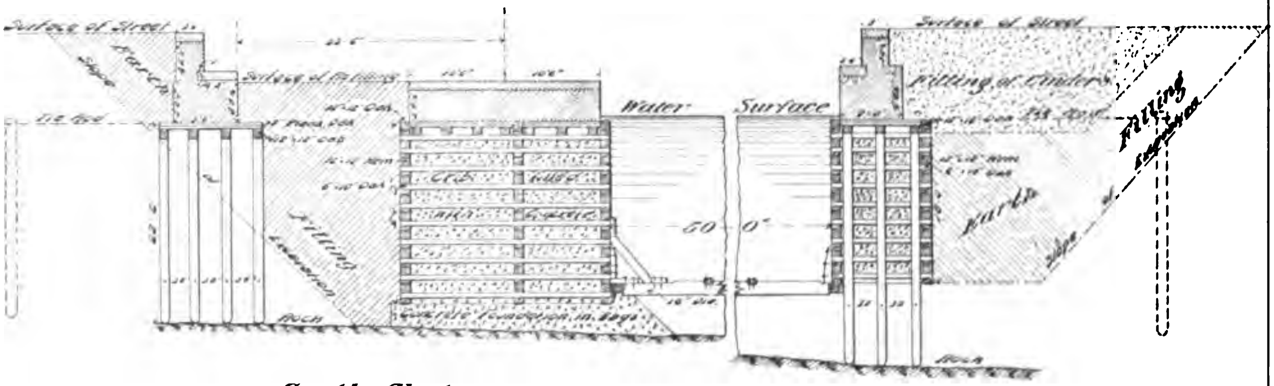
Over the Erie canal and slips connecting there are 222 bridges, of which 33 are built of wood, 21 of wood and iron, 109 of cast-iron and 59 of wrought iron and steel. All of the wooden bridges, with the exception of a few which have recently been renewed, are in bad repair. It is recommended that all wooden bridges be replaced as soon as possible with steel or iron structures.

Besides the bridges above mentioned, there are a number of others, an accurate list of which is not obtainable, which have been built by the State and which have to be kept in repair. These bridges are over abandoned canals, over streams that are or were used as feeders, and over streams in the Indian reservations. These last will be mentioned later, under repairs needed in the reservations.


N.
ELK
ST.
MIAMI
STREET
ST.
MACKINAW
Ohio
Slip
ST.
OHIO BASIN
SANDUSKY ST.
LOUISIANA
STREET
OHIO
BUFFALO HARBOR
Entrance
Slip
New Bridge
Map Showing
OHIO BASIN
and Vicinity
BUFFALO, N.Y.
Scale of Feet

Cross-section of Substructure of OHIO STREET BRIDGE, BUFFALO, N.Y.

Scale of Feet



South Abutment

North Abutment

EMERSON STREET BRIDGE, ROCHESTER.

During the year the following bridges were built. The cost of those built by contract, together with other details, can be found in the tables annexed:

Ohio street bridge, Buffalo, N. Y., act, chapter 145, Laws of 1894. The work done under this law consisted in removing the old bridge and replacing it by a new one, in building abutments for same, in dredging the Ohio basin so as to obtain 18 feet of water, and in rebuilding a portion of the docks along the slip. A great many difficulties were met with in the construction of the docks and of the bridge pier and abutments. In order to obtain a foundation for the pier, it was necessary to dredge to the rock, a distance of 25 feet. This rock surface was found very uneven, and a level foundation was made of concrete put in bags and placed in position by a diver. On this foundation a crib filled with concrete was sunk, and on top of the crib the masonry was placed. A section of the crib, foundation and masonry and a general plan of the basin and slip is here shown.

The principal items of work under this contract, in round numbers are as follows:

Eighty thousand cubic yards of earth excavated by dredge.

Six thousand cubic yards of earth embankment.

Four hundred yards of masonry.

Twelve hundred and ten cubic yards of concrete.

One hundred and twenty-four thousand feet B. M. oak lumber.

Thirty-eight thousand feet B. M. pine lumber.

One hundred and three thousand feet B. M. hemlock lumber.

Thirteen thousand linear feet oak piles, driven.

Forty thousand pounds bolts and nails.

The bridge itself is a "bob-tail" swing, the long arm being 64 feet and the short arm 31 feet 6 inches. The roadway in the clear is 16 feet 4 inches and the single sidewalk 4 feet 9 inches. The weight of the counterweight is 36,000 pounds. The bridge has worked well since it has been erected.

Bridge at Main street, Fairport, N. Y., act, chapter 526, Laws of 1894, and act, chapter 151, Laws of 1895.

The work consisted in removing the old bridge, lengthening and strengthening the old abutments and placing on them a new plate

girder bridge with a clear span of 84 feet, a 21.35 foot roadway and two sidewalks each 7.2 feet wide.

Bridge at Mill street, Buffalo, act, chapter 18, Laws of 1895.

The work was the same as that at Main street, Fairport. The new bridge, which replaces a wooden one, is of steel, has a clear span of 116.9 feet, one 21.5-foot roadway and two 6-foot sidewalks.

Bridge at Main street, Newark, N. Y., act, chapter 217, Laws of 1895.

The work was the same as at the two above-mentioned places. The bridge is of steel, has a clear span of 78.5 feet, one 31-foot roadway and two sidewalks 7.25 feet wide.

Besides the above work on bridges, the substructure for the Emerson street lift-bridge was completed, act, chapter 336, Laws of 1893, and act, chapter 56[illegible], Laws of 1894.

A new abutment was built under the Scott street bridge over the Clark and Skinner canal in Buffalo, act, chapter 947, Laws of 1896.

The bridge work, now being done by contract, can be seen in the table of contracts pending.

Besides the contract work above mentioned, the following bridges have been renewed or replaced by the forces of the Superintendent of Public Works:

A new pier was put under the Ferry street swing-bridge, which was damaged and knocked from its bearings by a passing boat.

Bridges Nos. 12, 19, 36 and 43 have been rebuilt and very many others have been repaired. Thirty bridges, most of them in Buffalo, have been repainted.

New bridges should be built at Elk street, over the Clark and Skinner canal; at Chicago street, over the Hamburgh canal; and at Georgia street and Erie street, over the Erie canal, all in the city of Buffalo. All of these bridges are too light for the present traffic. An accident is liable to happen at any time. The bridge across the river lock slip at Tonawanda should be rebuilt. The Pine street bridge at Lockport is in a very dangerous condition. The lift-bridge at West Main street, Rochester, is a very poor structure, and is constantly being hung up for repairs. It is in a very dangerous condition. The swing-bridge at Exchange street,

Rochester, will hardly last through another year. It is nothing now but a mass of patches. It should certainly be rebuilt at once. Farm bridges Nos. 7 and 8 should be rebuilt.

CONSTRUCTION WORK.

The tables headed "Contracts completed" and "Contracts pending" show the contract work which was looked after by this department, and for which plans, specifications and estimates were furnished. In addition to this, a number of surveys have been made for the Superintendent of Public Works. The following pieces of work, which were done or are being done by the Superintendent of Public Works, were also planned and directed from this office:

Improving Tonawanda State ditch, act, chapter 19, Laws of 1895; appropriation, $20,000.

Improving Beeman's creek, act, chapter 94, Laws of 1895; appropriation, $1,000.

Protection of highways at Red House, act, chapter 932, Laws of 1895; appropriation, $2,000.

Repairs to bridges and highways, Cattaraugus Indian reservation, act, chapter 932, Laws of 1895; appropriation, $2,000.

Repairs to Versailles bridge, Cattaraugus Indian Reservation, act, chapter 932, Laws of 1895; appropriation, $2,000.

Lengthening Cuba reservior spillway, act, chapter 932, Laws of 1895; appropriation, $2,500.

New culvert at Diven's ditch, Chemung county, act, chapter 932, Laws of 1895; appropriation, $3,000.

Improving abutments to Chemung bridge, act, chapter 932, Laws of 1895; appropriation, $1,500.

Repairs to Chemung canal, act, chapter 932, Laws of 1895; appropriation, $2,000.

Repairing Erie basin dock, act, chapter 489, Laws of 1896; appropriation, $867.

Improving roads, Cattaraugus Indian reservation, act, chapter 949, Laws of 1896; appropriation, $2,000.

Enlarging Cuba reservoir spillway, act, chapter 950, Laws of 1896; appropriation, $2,000.

Repairing Diven's culvert, act, chapter 950, Laws of 1896; appropriation, $1,000.

Improving roads and bridges, Tonawanda Indian reservation, act, chapter 950, Laws of 1896; appropriation, $1,000.

Dredging Findlay's lake, act, chapter 950, Laws of 1896; appropriation, $2,000.

Dredging Lower Black Rock harbor, act, chapter 320, Laws of 1895; appropriation, $10,000.

New protection wall at Germania park, Buffalo, act, chapter 947, Laws of 1896; appropriation, $4,230.

Raising dyke along Genesee river, act, chapter 947, Laws of 1896; appropriation, $1,300.

Plans, specifications and estimates for the following proposed improvements have been sent to Albany for approval:

Rebuilding culverts Nos. 1 and 2, act, chapter 947, Laws of 1896.

Rebuilding Brighton waste-weir and north head wall of Allen's creek culvert, act, chapter 947, Laws of 1896.

Rebuilding culverts Nos. 36 and 38, act, chapter 947, Laws of 1896.

Rebuilding berme abutment of Jay street bridge, Rochester, N. Y., act, chapter 947, Laws of 1896.

Reconstructing Medina road culvert, act, chapter 947, Laws of 1896.

Removing old pile docking in Tonawanda creek, act, chapter 947, Laws of 1896.

Repairing Lockport, Middleport and Mabee's waste-weirs, act, chapter 947, Laws of 1896.

Repairing abutments of Cook's bridge, lengthening and repairing culverts Nos. 33 and 34 and rebuilding culvert No. 32, act, chapter 947, Laws of 1896.

Bridge over the Erie canal at Exchange street, Rochester, act, chapter 514, Laws of 1895; appropriation, $25,000.

Repairing wall along Falls creek, at Havana, N. Y., act, chapter 797, Laws of 1896; appropriation, $5,000.

Rebuilding culvert under Genesee river feeder in Rochester, N. Y., act, chapter 947, Laws of 1896.

NAVIGATION.

There has been no delay in navigation during the year except that due to low water in Lake Erie. No breaks have occurred during the season of navigation; but on March 29th and March 31st a flood occurred in Tonawanda creek which resulted in the washing out of the Tonawanda spillway. The break was repaired before navigation opened. The reason for the break is as follows: The annexed sketch will show the situation of the different objects mentioned. The Erie canal from Buffalo to Tonawanda is artificial; at Tonawanda it enters Tonawanda creek just above its mouth and navigation travels up that creek to Pendleton, a distance of 11.6 miles. From that point on the channel is again artificial. In order to keep at all times a sufficient depth of water in Tonawanda creek, a dam about 4 feet high was built across its mouth (marked "a" in sketch). Tonawanda creek, during the season of navigation, rarely raises, and the current, as a usual thing, flows from Lake Erie up Tonawanda creek, and so on east.

During high water in the creek, which rarely, if ever occurs during the season of navigation, the currents from Lake Erie and the creek meet at Tonawanda, and the surplus water wastes over the dam and the spillway (marked "b").

At Black Rock, a short distance below where any feed from Lake Erie enters the canal, is a guard lock which can be shut, and thus keep back any Lake Erie water from coming to Tonawanda. A short distance above Pendleton is another guard lock which, when closed, keeps any water from Tonawanda creek when that creek is high, from backing up and flowing east along the canal. This is to prevent any damage from a great amount of water coming through the Lockport locks. It is thus seen that all water coming from Tonawanda creek, in time of flood, must pass into the Niagara river over the dam (a) and the spillway (b). On March 30, 1896, the water in Tonawanda creek at Pendleton, due to the melting of a very heavy snowfall, rose to a height of 10 feet above normal. The country which the creek drains is very flat, and consequently the water runs off very slowly. The main channel of the creek was covered with ice two feet thick.

The ice started to go out on the evening of the 30th. Tied along the dock (marked "c") were a number of boats. The ice was so heavy that, when it reached this dock, the water at that time being almost up to the level of the dock, instead of passing under the dock and over the dam, it passed on, carrying with it a number of boats and attempted to reach the river over the spillway. The result was that the spillway was carried out and two boats went out with the ice.

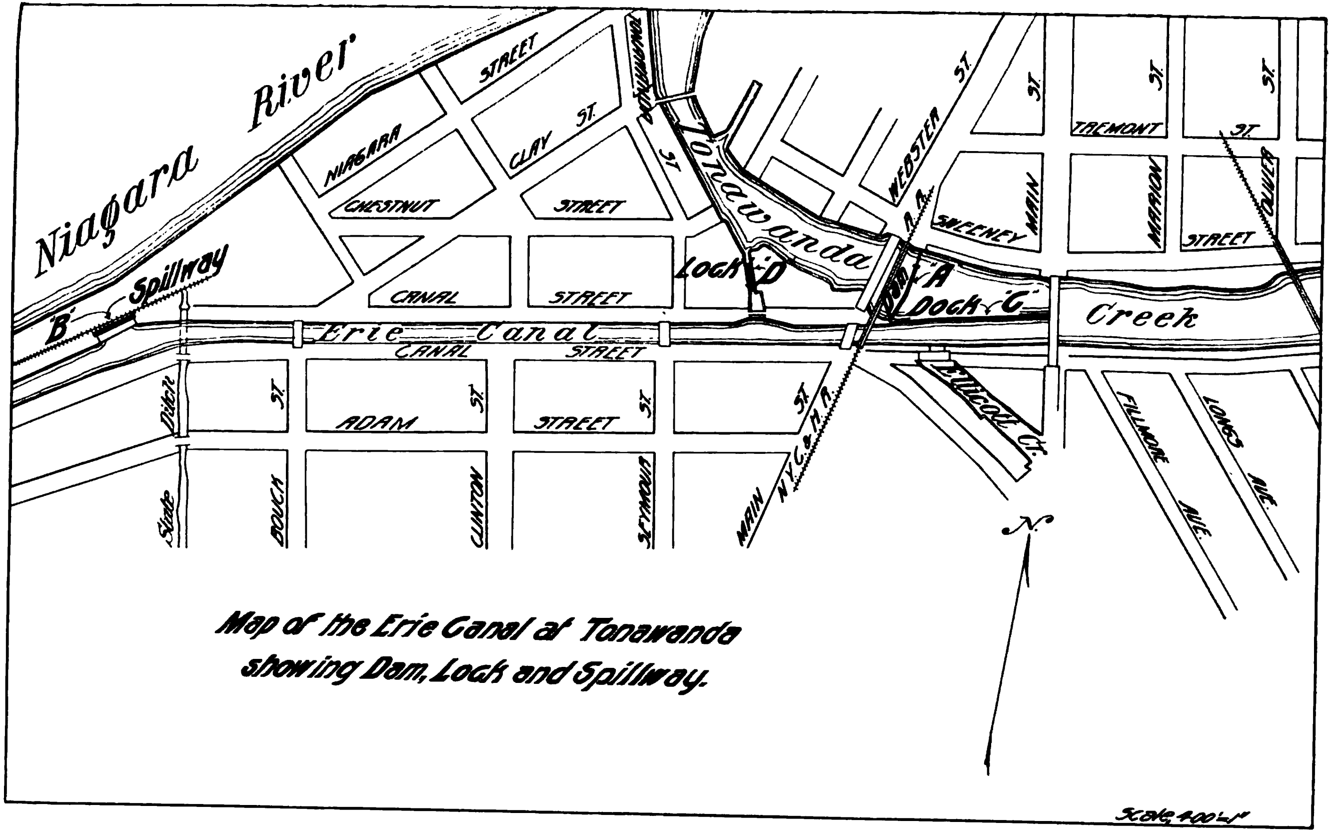
The break and the loss of boats was serious, but the greatest expense to the State will undoubtedly come from damage claims for flooded lands, the basis for such claims being that the State in constructing the dam across the creek mouth has backed the water up, and is so liable for any damage that may occur from floods. This sounds reasonable, and has, in years past, resulted in the State's paying many damage claims. I think, however, that the dam has little, if anything, to do with it, unless it be in the near vicinity of Tonawanda. The whole country is so flat, and the bed of the stream has so little fall, that, even if the dam were not there, the floods would still occur. Still, to prevent any future claims for damages the following is recommended:

The river lock (marked "d") is in bad shape. The dock "c" prevents ice from passing over the dam and should be removed. The dam "a" should be removed and replaced by some form of movable dam combined with a river lock, the present one "d" being closed. Then, after navigation closed, the dam could be lowered, the bed of Tonawanda creek being thus restored to its original state.

In this way the State could no longer be held liable for damage, at least for damage due to a dam across the creek.

GENESEE RIVER DAM.

This dam was constructed to turn water into the Genesee feeder and thence into the Erie canal at Rochester. Originally it served its purpose. The mill owners of Rochester and the State have always had more or less trouble as to who should have the use of the water in the Genesee river. The flash boards on portions



Map of the Erie Canal at Tonawanda showing Dam, Lock and Spillway.

of the present dam have been removed, so as to give the millers more water during the summer months, when the river is very low. For this reason the gates, where the river enters the feeder, have to be kept shut during low water to prevent the canal water, through the feeder, from flowing into the river.

With the dam in its present condition, no feed can be obtained from the river except during high water, and as this rarely occurs during the summer months, the Genesee river is practically useless as a source of water supply. This dam should be torn down and a new one of masonry built in its place. Surveys are now being made with this object in view, but no estimate of cost can be given yet.

OLD CANAL AT HOLLEY.

When the course of the canal near Holley was changed, a short length of the old canal was still kept open. At present this branch canal, about 3,000 feet long, is used by only one company for shipping purposes, and its output is very small. The banks of this branch canal are very high and in very poor shape. A spillway located near its end is also in bad shape.

It is recommended to abandon this branch canal, dam its mouth, and, in place of the Holley spillway on the main line of the canal, which must be rebuilt in any case, to erect a new spillway with a capacity equal to that of the two present spillways.

ERIE BASIN, BUFFALO, N. Y.

The Erie basin, probably one of the most valuable harbors in Buffalo, is in very bad shape.

About fifty feet of one end of the breakwater has fallen away. The piers extending from the breakwater into the basin have rotted away, and the basin between and around these piers has been filled up with mud, timber and sunken boats until that portion of the basin is practically useless. There is always great difficulty in finding room for canal boats to lay during the winter months, and for that reason, if for no other, the basin should be

put in repair. It is recommended that that portion of the basin between the breakwater and the dotted line shown on the accompanying map be dredged to obtain twelve feet of water and the rest of the basin be dredged to obtain eighteen feet of water, or as near those depths as possible without excavating any rock. Also that new piers and a crib island, as shown on the plan, be constructed. Careful soundings have been taken over the whole basin, and the following is the estimated cost of the work:

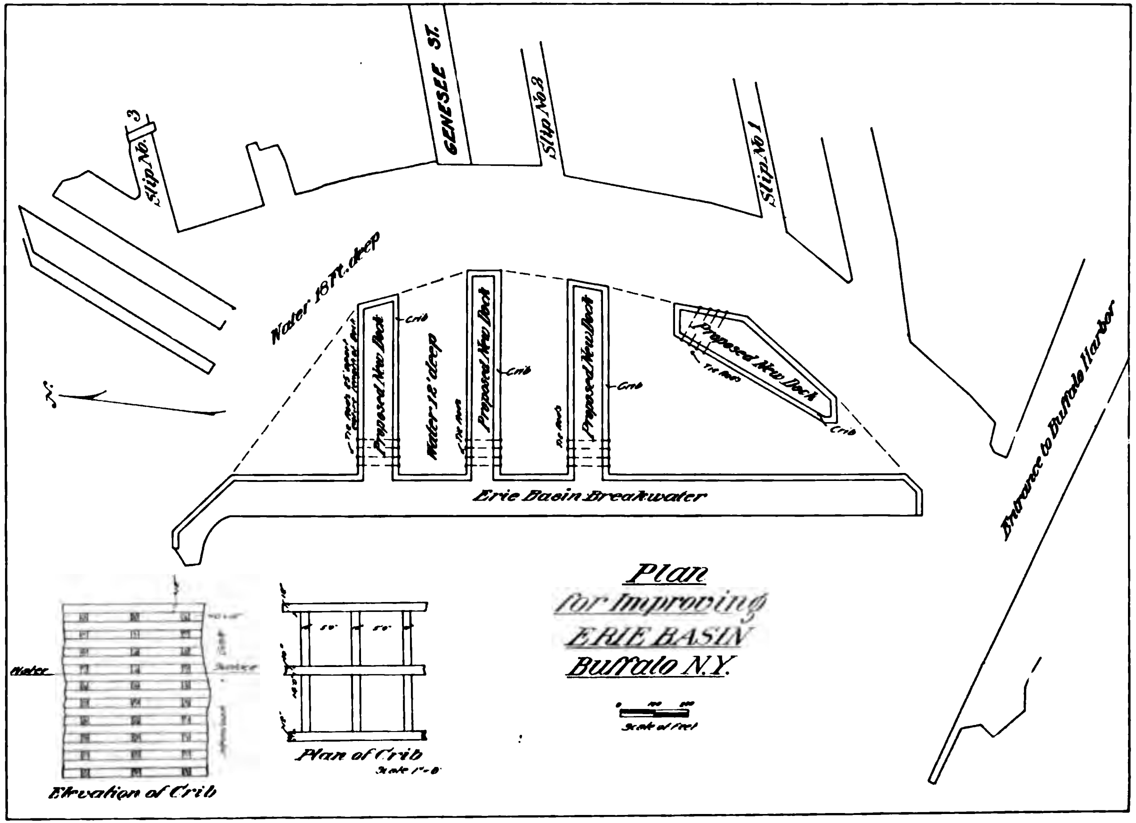
Quantity.	ITEM.	Price.	Amount.
228,000	Cubic yards wet excavation of earth	$0 17	$38,760 00
55,000	Cubic yards earth filling between cribs	25	13,750 00
66,700	Cubic yards loose stone filling in cribs	2 00	133,400 00
37,000	Feet B. M. hemlock timber in cribs	19 00	64,030 00
265,000	Feet B. M. oak timber in cribs	33 00	87,450 00
40,000	Pounds wrought-iron tie rods	04	1,600 00
150	Snubbing posts	10 00	1,500 00
1	Removing wrecks	5,000 00	5,000 00
1	Repairing breakwater	10,000 00	10,000 00
	Total	....	$355,490 00
	Engineering and incidentals	....	35,610 00
	Grand total	....	$391,100 00

HAMBURG CANAL.

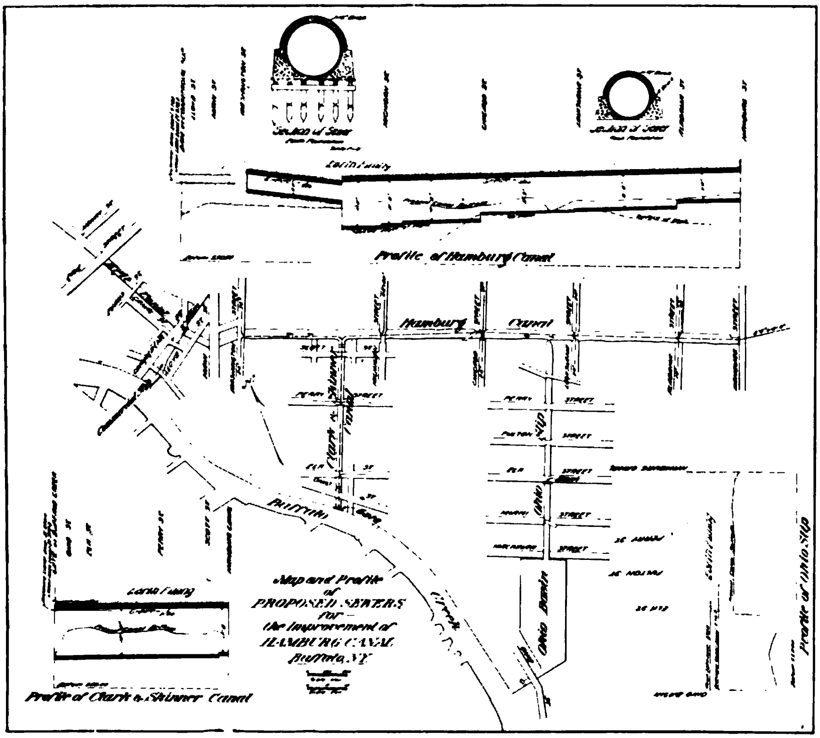
Section 8, article 7 of the Constitution of the State of New York provides that the Main and Hamburg canal may be leased or sold, the proceeds of such lease or sale to be applied to the improvement, superintendence or repair of the remaining portions of the canals.

The State, with little or no restrictions, has allowed the city of Buffalo and its citizens to empty sewage into the Hamburg and Erie canals. The Erie canal, because of its situation and because of its constant use for navigation purposes, is not so badly polluted as the Hamburg and its slips. The Hamburg canal, situated as it is, has no current, and has not in a number of years been used for navigation, and has become nothing more than a stagnant body of water into which a large amount of Buffalo's drainage empties.

The Hamburg canal was built in 1846, and as early as 1855 attempts were made to abate the nuisance it then created. From



Plan
for Improving
ERIE BASIN
Buffalo N.Y.
Scale of Feet
GENESEE ST.
Slip No. 3
Slip No. 2
Slip No 1
Water 18 Ft. deep
Water 12' deep
Proposed New Dock
Proposed New Dock
Proposed New Dock
Proposed New Dock
Crib
Crib
Crib
Crib
Tie Rods
Tie Rods
Tie Rods
Erie Basin Breakwater
Entrance to Buffalo Harbor
N.
Plan of Crib
Elevation of Crib
Water



Map and Profile
of
PROPOSED SEWERS
for
the Improvement of
HAMBURG CANAL
Buffalo, N.Y.
Profile of Hamburg Canal
Profile of Clark & Skinner Canal
Profile of Ohio Slip
Hamburg Canal
Clark & Skinner Canal
Buffalo River
Ohio Basin
Ohio Slip
PERRY STREET
FULTON STREET
ELK STREET

that time until 1882 various plans were tried to create a current in the canal and thus cleanse it; but none were successful. In 1882 Col. G. E. Waring proposed to relieve the difficulty by constructing an intercepting sewer, running generally parallel to the Hamburg and Erie canals and emptying into the Niagara river near Ferry street.

The sewer was built, but proved a failure, either from faulty construction or design, and the condition of the Hamburg is as bad now as it ever was. For the last few years the city has been spending $6,000 per year operating pumps and wheels to create a current. The current, however, is not apparent.

In view of the great importance of abating the Hamburg canal nuisance, both to the city of Buffalo and to the State of New York, the following plan and estimate are submitted. A reference to the accompanying map will show the location of all points mentioned. No money was available for making this plan and estimate, so the work has been done at odd times, and the data necessary has been largely obtained from records in the Buffalo city engineer's office and in this office. No detail plans for the sewer proper have been made, but there is no doubt that the estimated cost is not too small, and that the size of the proposed sewers would be changed little, if any, by further calculation.

PLAN FOR ABATING THE HAMBURG CANAL NUISANCE.

The plan in general consists in constructing a sewer in the place now occupied by the Hamburg and Clark & Skinner canals. The outlet of the proposed sewer is to be at the junction of the Clark & Skinner canal with Buffalo creek. The sewer extends up the Clark & Skinner canal to its junction with the Hamburg, where it is joined by two sewers located in the Hamburg, one coming west from Hamburg street and the other coming east from Washington street. The sizes of the different portions of the sewer can be found on the map. After this sewer has been constructed, all intercepted sewers being connected, dams are to be built across the Hamburg canal at Commercial street and across the Ohio

slip at Elk street, and all of the Hamburg canal and all of the Clark & Skinner canal and that portion of the Ohio slip between Elk street and the Hamburg canal are to be filled to an elevation six feet above Lake Erie water surface, except at street crossings, where the embankment would be carried up to th natural street grade. A gate is also to be put in at the outlet so that the sewer can, when necessary, be pumped out and cleaned. It might be well to state here that the Clark & Skinner canal and that portion of the Ohio slip which it is proposed to abandon are at present practically of no use for navigation.

The objection which will at once be raised to this plan will be the fact that it is proposed to empty a large amount of sewage into Buffalo creek, which reaches the Niagara river above the intake of the city water-works; but, as all this sewage now reaches the same place, the objection does not hold. I also believe that the amount of sewage reaching the Niagara river under the proposed plan would be very much less than at present, as a great deal of the present pollution of the Hamburg canal and its tributaries is due to factories along the shores dumping their refuse into the canal. This practice would, of course, have to be stopped after the canal had been filled.

I shall not go into details as to the calculations by which the sizes of the sewers were arrived at. The area drained was taken at 3,640 acres, with an average slope of 3.5 feet per 1,000 feet, and the population was assumed at 60,000. The water consumption per capita was taken from the city reports at 250 gallons per day, which is probably much in excess. The rainwater that could reach the sewer was taken at the rate of one inch of water falling per hour on the territory drained. A careful calculation was made of the largest amount of sewage that could be emptied into the proposed sewer by sewers that would intercept. The present 8-foot intercepting sewer was calculated to carry 115.6 cubic feet per second. The sewers at present emptying into the Ohio slip can be carried on to the Clark & Skinner outlet. The cost of this is not included in the following estimate:

Estimate of the cost of abating the Hamburg Canal Nuisance.

Quantity.	ITEM.	Amount.
1	Bailing and draining	$50,000 00
6,870	Lineal feet brick sewer, including pile foundation and excavation	133,200 00
309,000	Cubic yards embankment	154,500 00
9	Manholes	1,100 00
1	Gate	1,100 00
2	Dams	12,700 00
	Total	$352,600 00
	Engineering and incidentals	36,400 00
	Total cost	$389,000 00

Should this plan be followed there would be reclaimed about 23 acres of land which is now occupied by the canals, and the sanitary condition of 3,640 acres would be vastly improved, while that of the rest of the city would be no worse than it is now. If at any time it should be deemed advisable to build another and larger intercepting sewer, the cost of which, if it were large enough to be of any use, would be immense, the work done under the proposed plan would not be lost, as any intercepting sewer could start from the Hamburg canal where it joins the Clark & Skinner canal. From a financial point of view the plan is feasible. Twenty-three acres of land would be reclaimed, and this land, at $50,000 per acre, which is an average of what the surrounding property is assessed, would be worth $1,150,000. The difference between this sum and the estimated cost, even if one decreases and the other increases to a considerable extent, would be ample to pay for any damage claims that might arise. Besides this, there are ten bridges crossing the canal, which the State owns, and which would be removed and all expense of maintenance done away with.

The three feasible methods by which this plan could be carried out are as follows:

(1). The State could do the work itself and afterwards dispose of the reclaimed land.

(2). The State could give the canals as they are to the city of Buffalo, subject to the city's building the sewer under State direction.

(3). The State could sell the canals as they are to the highest bidder, subject to said bidder's building the sewer under State direction.

The first plan would probably be the best, and the last the cheapest.

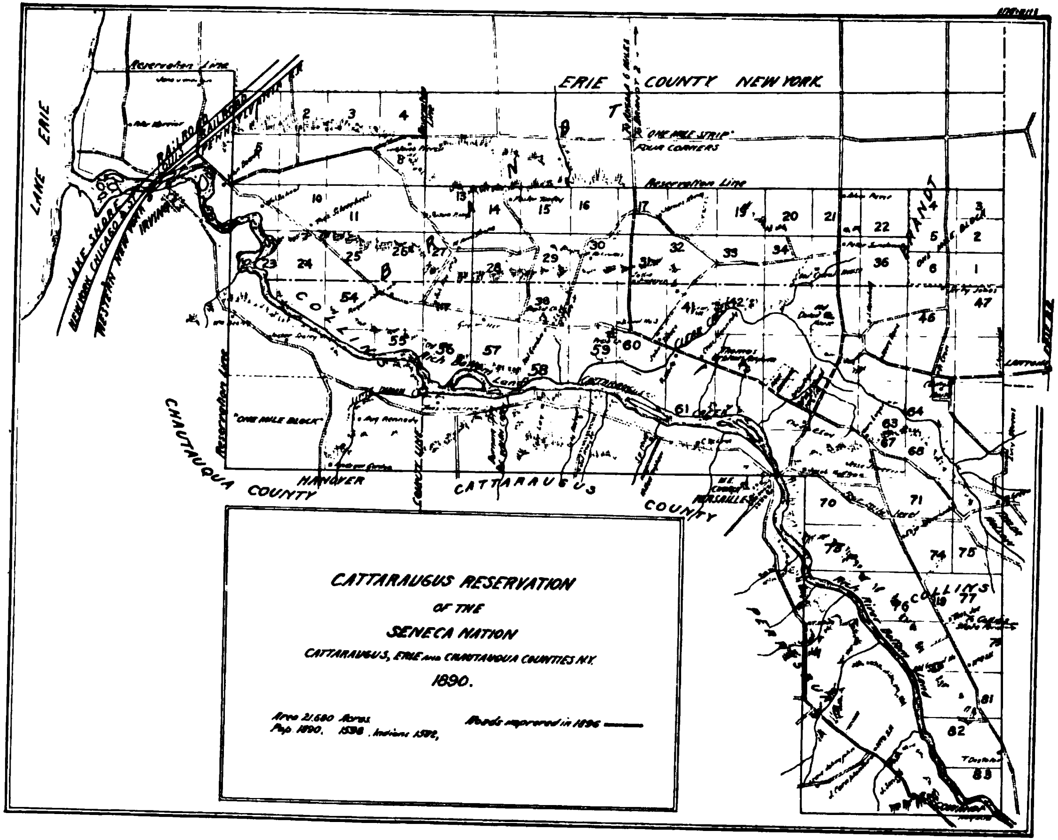
In order to carry out this plan, further legislation might be necessary before the State could dispose of or close up the Clark & Skinner canal and the Ohio slip.

REPAIRS AND IMPROVEMENTS TO HIGHWAYS AND BRIDGES, CATTARAUGUS INDIAN RESERVATION.

Act, chapter 949-950, Laws of 1896.

The money appropriated under the above acts has been wisely and economically expended. A total of thirteen miles of highway has been improved, four of which have been turnpiked, making a thirty-foot roadway with good ditches and partially graveled; Lawton hill, Plank Road hill, Gowanda hill and Brant hill, formerly narrow, badly- gullied and nearly impassable hill roads have been well ditched and graded to a uniform gradient. The large bridge over Cattaraugus creek, near Versailles, has been thoroughly repaired, defective braces, chord members and floor renewed and masonry thoroughly pointed. This bridge will require no further repairs for several years. The two-span bridge over Clear creek, near Thomas Orphan Asylum, has been temporarily repaired. That future appropriations for the betterment of the highways on this reservation may be secured for the best interests of the State, the following list of improvements is respectfully submitted, placed in the order of urgency:

Bridge over Clear creek, one mile west of Thomas Orphan Asylum, consisting of two 60-foot span timber trusses on defective masonry and pile abutments and pier, now badly decayed and in unsafe condition, with east approach exposed to the action of the creek. This bridge should be renewed and protected at the earliest possible moment. Two 60-foot spans, 16-foot roadway, steel bridge


CATTARAUGUS RESERVATION
OF THE
SENECA NATION
CATTARAUGUS, ERIE AND CHAUTAUQUA COUNTIES N.Y.
1890.
Area 21,680 Acres
Pop. 1890, 1538, Indians 1512,
Roads improved in 1896
ERIE COUNTY NEW YORK
CATTARAUGUS COUNTY
CHAUTAUQUA COUNTY
LAKE ERIE
"ONE MILE STRIP"
FOUR CORNERS
Reservation Line
"ONE MILE BLOCK"
HANOVER
COLLINS
PERRYSBURG
VERSAILLES
Rich Bottom Land
LAKE SHORE
NEW YORK CHICAGO & ST. L.
WESTERN NEW YORK & PENN.

on masonry abutments and pier, with east approach graded and up-stream bank veneered with flat stone is recommended. Estimated expense, $4,000.

Bridge over small stream northwest of Gowanda, now badly decayed and blocked up on light, defective masonry. Should be replaced by a 14-foot rubble arch. The bridge being only 14-feet span, with high abutments, the arch will be the most economical construction. Estimated expense, $1,300.

Turnpiking road, Irving to Thomas Orphan Asylum, 7 miles. Estimated expense, $1,000.

Turnpiking road, Thomas Orphan Asylum to Gowanda and Collins State Farm. Estimated expense, $500.

Complete graveling road, Lawton to Thomas Orphan Asylum. Estimated expense, $1,300.

The map and photographs annexed will show the location and condition of the various places mentioned.

Act, chapter 950, Laws of 1896.

Dredging and removing obstructions in Findlay's lake, county of Chautauqua.

This work, which was done by the Superintendent of Public Works, consisted in removing stumps and logs from the bed of the lake.

ERIE CANAL IMPROVEMENT.

Act, chapter 79, Laws of 1895, and act, chapter 794, Laws of 1896.

Work on the surveys for this improvement, which is to consist in deepening the Erie canal so that a depth of nine feet of water will be obtained, was started on January 13, 1896. To facilitate the work, the division was divided into eleven sections, and an assistant engineer put in charge of each section. The following table will show the division and the names of the assistant engineers in charge:

Sec. No.	From	To	Assistant engineer	Dist.
13....	Wayne Co. Line Bridge ..	Poor House, lock 56	G. O. House	15.958
14....	Poor House, lock 56	Lock 61	James W. Reed	16.438
15....	Lock 61	Lock 62	H. P. Gillette	17.168
16....	Lock 62	Rowe Street bridge	George E Greene	9.213
17....	Rowe Street bridge	Cooley's Basin bridge	C. T. Middlebrook,, Jr .	14.188
18....	Cooley's Basin bridge	Brailey's bridge	Boyd Eble	15.049
19....	Brailey's bridge	Shelby Basin bridge	Munson Nichols	14.561
20....	Shelby Basin bridge	Cady bridge, Lockport	C. H Flanigan	14.067
21....	Cady bridge, Lockport ...	Bush's bridge	H. A. Van Alstyne	14.730
22....	Bush's bridge	Guard lock, Black Rock ..	D. D. Waldo	11.965
23....	Guard lock, Black Rock ..	Buffalo, inc. slips	O. S. Wilson	5.025

Each party consisted of an assistant engineer, 2 levelers, 2 rodmen, 4 chainmen, and from 4 to 6 laborers. As soon as cross-sectioning was started, assistant engineers each night would send their notes to the Rochester office, where they were plotted up and the amount of excavation calculated.

All plans for necessary new bridges or other structures were also made in the Rochester office.

The winter of 1896 was unusually severe, and, on account of the cold weather and the great amount of snow, the work on the surveys was necessarily slower than it would have been under more favorable circumstances.

It being impossible to draw the water from sections 22 and 23 and from part of section 21, the cross-sections on that portion of the canal had to be taken by soundings either from ice or from floats. Where the canal bottom was of earth, cross-sections were taken every 100 feet, and where its was of rock, every 25 feet.

Besides the work of cross-sectioning, a complete map and survey of the entire canal property has been made, showing the adjoining property for 300 or 400 feet on each side of the canal, and the location of all bridges and other structures.

At the present writing, rough estimates of the cost of the improvement have been made, but the data at hand is not yet complete enough to give correct estimates of the cost.

The division has been in charge of J. L. Little as division engineer during the entire year, with A. T. Jones as resident engineer

from September 30, 1895, to June 30, 1896, and C. R. Neher as resident engineer from July 15, 1896, to September 30, 1896.

A statement of the engineering expenses of the division is hereto annexed, showing in detail the names of the persons employed, time of service and compensation of each; also one showing contracts pending and another showing contracts completed, and final accounts rendered during the year.

Respectfullly submitted,

J. L. LITTLE,

Division Engineer.

WESTERN DIVISION, ERIE CANAL.

Table showing contracts finished during the year ending September 30, 1896.

CONTRACTOR.	Contract signed.	Work finished.	Character of work.	Legislative Act. Chap.	Legislative Act. Laws.	Appropriation.	Engineer's estimate.	Contract price.	Final estimate.
Buffalo Dredging Co	Dec. 28, 1894	Dec. 7, 1895	Docking and dredging in the Ohio basin and substructure for Ohio st. bridge, Buffalo.	145	1894	$60,000 00	$43,297 00	$36,328 00	$47,125 00
Wrought Iron Bridge Co	Dec. 28, 1894	Nov. 26, 1895	Superstructure for Ohio st. bridge, Buffalo	145	1894	....	8,217 00	5,624 00	5,814 00
Wrought Iron Bridge Co	Feb. 18, 1895	Oct. 17, 1895	Superstructure for Emerson st. bridge, Rochester	336 560	1893 1894	17,000 00	9,974 27	9,940 00	* 10,214 44
Chambers & Casey	May 9, 1895	May 16, 1896	Substructure for bridge at Main st., Fairport	576 151	1894 1895	16,500 00	6,044 00	5,198 00	6,517 84
Rochester Bridge & Iron Wks.	Oct. 10, 1895	May 2, 1896	Superstructure for bridge at Main st., Fairport	576 151	1894 1895		6,000 00	7,796 00	7,796 00
Brayer & Albaugh	Oct. 14, 1895	Dec. 7, 1895	Improvement of Glen creek, Watkins	140	1895	5,000 00	3,902 00	3,139 60	4,286 11
Hilton Bridge Co	July 27, 1895	April 25, 1896	Approach and bridge at Mill st., Buffalo	18	1895	9,500 00	6,440 00	6,944 50	7,213 58
J. J. Churchyard	Aug. 8, 1895	Dec. 18, 1895	Docking and dredging in Erie basin, Buffalo	224	1895	5,378 00	4,473 40	4,321 90	4,802 39
R. E. Beardsley & Co	Aug. 24, 1895	Nov. 13, 1895	Brick sewer, Horseheads	679	1895	10,000 00	7,420 25	6,984 50	7,181 91
R. E. Beardsley & Co	July 16, 1896	Aug. 29, 1896	Continuation of above contract	679	1895		1,382 50	1,382 50	1,394 05
Rochester Bridge & Iron Wks.	Sept. 2, 1895	Aug. 7, 1896	Iron bridge at Main st., Newark, N. Y	217	1895	8,000 00	6,821 20	5,899 90	6,155 10
Frank J. Le Valley	Sept. 11, 1895	Oct. 25, 1895	Ditching and iron culvert, Pendleton, N. Y	17	1895	2,000 00	1,819 60	1,780 05	1,877 37
W. S. Beckhorn	Oct. 9, 1895	Dec. 3, 1895	Improving Catharine creek, Havana	453	1895	1,500 00	1,064 25	1,090 00	964 82
W. T. O'Connor	Oct. 14, 1895	Jan. 18, 1896	Improving Mud creek, Lockport	307	1895	10,000 00	9,000 00	8,632 00	8,612 92
E. J. Hingston	Oct. 15, 1895	Sept. 17, 1896	Dredging Seneca lake level, Chemung canal	572 482	1894 1896	4,000 00	3,752 00	3,470 00	3,303 25

R. E. Beardsley & Co.	Nov. 1, 1895	Jan. 6, 1896	Dyke on bank of Chemung river, Corning	221	1895	8,000 00	6,690 00	5,348 00	5,740 15
Hingston & Woods	Nov. 2, 1895	Dec. 24, 1895	Dredging lower Black Rock harbor	320	1895	10,000 00	4,500 00	2,610 00	2,281 14
Dodge & McGregor	Nov. 8, 1895	Sept. 15, 1896	Improving Bull creek	547	1895	8,000 00	6,500 00	4,650 00	6,267 30
William Fuller	Jan. 8, 1896	April 25, 1896	Retaining Wall at South St. Paul st., Rochester	653	1894	2,500 00	1,822 00	1,018 00	1,785 58
Dodge & McGregor	July 7, 1896	Sept. 24, 1896	Rebuilding Scott st. abutment, Buffalo	947	1896	....	3,600 00	3,293 90	3,208 74

* The substructure for this bridge was finished last year and the cost came out of the same appropriation.

Table showing contracts pending September 30, 1896.

CONTRACTOR.	Date of contract.	Character of work.	LEGISLATIVE ACT. Chapter.	LEGISLATIVE ACT. Laws.	Appropriation.	Engineer's estimate.	Contract price.	Payments to date.
Logie & Leh	Dec. 26, 1894	Removing Porter avenue bridge to Jersey street, Buffalo	668 482	1894 1896	$10,000 00	$1,000 00	$946 25	....
Buffalo Dredging Co	May 8, 1896	Substructure for Porter avenue bridge, Buffalo	590 482	1895 1896				
Buffalo Bridge and Iron Wks	May 9, 1896	Superstructure for Porter avenue bridge, Buffalo	590 482	1895 1896	62,500 00	25,556 25	19,497 75	$10,880 00
					....	46,098 00	51,500 00	....
Frank J. Le Valley	Aug. 29, 1896	Improving Mud creek, Lockport	477	1896	15,000 00	12,672 00	8,810 00	595 00
White & Coughlin	Feb. 21, 1896	Bridge at Schuyler street, Havana	57	1895	5,000 00	4,932 50	3,972 00	2,295 00
Connelly Bros	Sept. 21, 1896	Buoys for Erie basin, Buffalo	521	1896	416 00	250 00	232 50	....

STATEMENT giving names, rank, number of days and compensation of engineers upon the repairs of the Western Division of the New York State canals, with incidental expenses, during the fiscal year ending September 30, 1896, from October 1, 1895, to September 30, 1896.

Ordinary Repairs — Erie Canal.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
J. L. Little	Division engineer	194	$2,400 00 per year	$1,276 96	$455 38	$1,732 34
A. T. Jones	Resident engineer	168½	2,000 00 per year	923 50	146 03	1,069 53
C. R. Neher	Resident engineer	47	2,000 00 per year	255 43	114 03	369 46
M. W. Wilbur	First assistant engineer	122	6 00 per day	732 00	244 43	976 43
W. L. Curtis	Assistant engineer	115	5 00 per day	575 00	190 94	765 94
James W. Reed	Assistant engineer	14	5 00 per day	70 00	15 81	85 81
M. W. Wilbur	Leveler	70	5 00 per day	350 00	102 65	452 65
F. E. Holleran	Leveler	103	4 50 per day	463 50	54 33	517 83
D. D. Waldo	Leveler	81	4 50 per day	364 50	63 40	427 90
L. B. Fitch	Leveler	43	4 50 per day	193 50	14 77	208 27
J. B. Barrett	Rodman	184	3 50 per day	644 00	42 11	686 11
B. R. Salyerds	Rodman	21	3 50 per day	73 50	....	73 50
F. W. Hamilton	Rodman	97	3 50 per day	339 50	12 42	351 92
R. T. Webster	Chainman	17	3 50 per day	59 50	29 46	88 96
Henry Geck	Chainman	262½	2 50 per day	656 25	....	656 25
C. E. Whitcher	Chainman	38	2 50 per day	95 00	7 38	102 38
Clinton J. Bean	Chainman	9	2 50 per day	22 50	12 46	34 96
F. Mauerman	Chainman	41	2 50 per day	102 50	14 75	117 25
						$8,717 49
Incidental expenses.						
Livery						45 00
Telephone						94 00
Rent						500 00
Fuel and light						6 99
Postage and telegragh						45 76
Stationery						332 36
Miscellaneous						238 02
						$9,974 62

Extraordinary Repairs — Canal Improvements.

Chapter 79, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
J. L. Little	Division engineer	171	$2,400 00 per year	$1,123 04	$594 95	$1,717 99
A. T. Jones	Resident engineer	31	2,000 00 per year	169 40	20 71	190 11
C. R. Neher	Resident engineer	31	2,000 00 per year	170 33	99 48	269 81
M. W. Wilbur	First assistant engineer	137	6 00 per day	822 00	325 98	1,147 98
Geo. E. Greene	Assistant engineer	229	5 00 per day	1,145 00	41 27	1,186 27
C. T. Middlebrook, Jr.	Assistant engineer	179	5 00 per day	895 00	68 20	963 20
Boyd Ehle	Assistant engineer	226	5 00 per day	1,130 00	85 82	1,215 82
H. A. Van Alstyne	Assistant engineer	203	5 00 per day	1,015 00	140 44	1,155 44
O. S. Wilson	Assistant engineer	226	5 00 per day	1,180 00	257 84	1,387 84
Munson Nichols	Assistant engineer	67	5 00 per day	335 00	29 85	364 85
James W. Reed	Assistant engineer	167	5 00 per day	835 00	63 45	898 45
H. P. Gillette	Assistant engineer	110	5 00 per day	550 00	46 44	596 44
H. L. Noyes	Assistant engineer	20	5 00 per day	100 00	16 81	116 81
Munson Nichols	Leveler in charge	42	4 50 per day	189 00	8 88	197 88
C. H. Flanigan	Leveler in charge	190	4 50 per day	855 00	188 59	1,043 59
D. D. Waldo	Leveler in charge	123	4 50 per day	553 50	60 59	614 09
Garrett O. House	Leveler in charge	237	4 50 per day	1,066 50	99 32	1,165 82
William Crennell, Jr.	Leveler	183	4 50 per day	823 50	30 34	853 84
Frank Place	Leveler	60	4 50 per day	270 00	1 07	271 07
Francis O'Neil	Leveler	42	4 50 per day	189 00	3 82	192 82
Casper Scholz	Leveler	225	4 50 per day	1,012 50	24 53	1,037 03
Clark Brown	Leveler	93	4 50 per day	418 50	51 31	469 81
E. A. Sommer	Leveler	148	4 50 per day	666 00	36 88	702 88
L. B. Fitch	Leveler	111	4 50 per day	499 50	20 29	519 79
S. J. Steward	Leveler	176	4 50 per day	792 00	12 76	804 76
N. F. Hopkins	Leveler	227	4 50 per day	1,021 50	33 50	1,055 00
Carl L. Lund	Leveler	71	4 50 per day	319 50	20 95	340 45
A. F. Krause	Leveler	160	4 50 per day	720 00	3 59	723 59
C. S. Burns	Leveler	125	4 50 per day	562 50	29 98	592 48
F. E. Holleran	Leveler	81	4 50 per day	364 50	12 11	376 61
T. J. Morrison	Leveler	183	4 50 per day	823 50	3 58	827 08
S. G. Heater	Leveler	49	4 50 per day	220 50	18 98	239 48
F. H. Crafts	Leveler	112	4 50 per day	504 00	3 60	507 60
A. B Pomme	Leveler	80	4 50 per day	360 00	5 66	365 66
H. K. Bishop	Leveler	122	4 50 per day	549 00	11 27	560 27
H. D. Alexander	Leveler	183	4 50 per day	823 50	....	823 50
George J. Lord	Leveler	118	4 50 per day	531 00	....	531 00

S. D. Enoch	Rodman	180	3 50 per day	630 00	29 19	659 19
F. W. Hamilton	Rodman	108	3 50 per day	378 00	15 95	393 95
Charles G. Douw	Rodman	89	3 50 per day	311 50	27 26	338 76
G. H. Penfield	Rodman	132	3 50 per day	462 00	31 23	493 23
C. Bannister	Rodman	85	3 50 per day	297 50	1 30	298 80
Ray Morris	Rodman	100	3 50 per day	350 00	1 30	351 30
Isaac O. Cole	Rodman	175	3 50 per day	612 50	30 09	642 59
H. C. Copeland	Rodman	151	3 50 per day	528 50	28 51	557 01
Jos. W. Howe	Rodman	180	3 50 per day	630 00	39 57	669 57
James Thomson	Rodman	129	3 50 per day	451 50	24 32	475 82
E. R. Payne	Rodman	203	3 50 per day	710 50	35 70	746 20
Irving Hawkins	Rodman	165	3 50 per day	577 50	6 56	584 06
M. S. Smith	Rodman	176	3 50 per day	616 00	21 00	637 00
M. J. Ross	Rodman	115	3 50 per day	402 50	6 93	409 43
William W. Hoy	Rodman	36	3 50 per day	126 0	4 78	130 78
W. B. Gormley	Rodman	43	3 50 per day	150 50	4 91	155 41
H. G. McKelvey	Draughtsman	215	3 50 per day	752 50	....	752 50
C. A. Poole	Draughtsman	218	3 50 per day	763 00	80	763 80
R. T. Webster	Chainman	166	3 50 per day	581 00	20 44	601 44
Walter Dubey	Chainman	225	3 50 per day	787 50	....	787 50
Fred D. Haak	Chainman	160	4 00 per day	640 00	131 71	771 71
Fred D. Haak	Chainman	89	4 50 per day	400 50	74 54	475 04
James S. Cook	Chainman	227	2 50 per day	567 50	33 11	600 61
Fred W. Lee	Chainman	126	2 50 per day	315 00	24 85	339 85
J. J. McNulty	Chainman	87	2 50 per day	217 50	17 79	235 29
John T. Dowd	Chainman	85	2 50 per day	212 50	22 75	235 25
Charles F. Dietz	Chainman	38	2 50 per day	95 00	13 41	108 41
Josepd H. Wise	Chainman	87	2 50 per day	217 50	9 68	227 18
Alfred W. Provo	Chainman	85	2 50 per day	212 50	2 05	214 55
F. G. Moses	Chainman	225	2 50 per day	562 50	19 98	582 48
John G. Mislin	Chainman	132	2 50 per day	330 00	13 39	343 39
Guy E. Atherton	Chainman	178	2 50 per day	445 00	12 63	457 63
Howard Crounse	Chainman	175	2 50 per day	437 50	33 68	471 18
John O'Conner	Chainman	163	2 50 per day	407 50	12 38	419 88
A. J. Lipp	Chainman	102	2 50 per day	255 00	25 58	280 58
Fred W. Gerstner	Chainman	102	2 50 per day	255 00	27 06	282 06
W. F. Edgerton	Chainman	62	2 50 per day	155 00	15 30	170 30
W. F. Hurley	Chainman	134	2 50 per day	335 00	44 24	379 24
T. F. Cavanaugh	Chainman	100	2 50 per day	250 00	5 15	255 15
James H Parker	Chainman	19	2 50 per day	47 50	2 00	49 50
John Pinkel	Chainman	47	2 50 per day	117 50	3 70	121 20
F. Mauerman	Chainman	120	2 50 per day	300 00	....	300 00
C. H. Dennstadt	Chainman	154	2 50 per day	385 00	....	385 00
Wm. Schneider	Chainman	68	2 50 per day	170 00	....	170 00
Wm. Schneider	Chainman	157	3 50 per day	549 50	....	549 50
Emil J. Greiner	Chainman	96	2 50 per day	240 00	....	240 00
F. V. Searls	Chainman	111	2 50 per day	277 50	1 75	279 25
C. P. Sullivan	Chainman	179	2 50 per day	447 50	33 61	481 11
L. L. Melius	Chainman	135	2 50 per day	337 50	13 79	351 29

Extraordinary Repairs — Canal Improvements — (Concluded).

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. E. Whitcher	Chainman	68	$2 50 per day	$170 00	$7 28	$177 28
Tracy B. Smith	Chainman	134	2 50 per day	335 00	10 21	345 21
Le Roy Lewis, Jr	Chainman	42	2 50 per day	105 00	2 51	107 51
O. F. McAveune	Chainman	42	2 50 per day	105 00	3 58	108 58
Clinton J. Bean	Chainman	173	2 50 per day	432 50	23 84	456 34
James P. Shearer	Chainman	42	2 50 per day	105 00	3 01	108 01
Avery H. Wilcox	Chainman	108	2 50 per day	270 00	16 34	286 34
R. W. Swanton	Chainman	48	2 50 per day	120 00	7 17	127 17
Levi J. Decker	Chainman	46	2 50 per day	115 00	4 73	119 73
Arthur W. Peters	Chainman	160	2 50 per day	400 00	29 99	429 99
B. R. Dingley	Laborer	40	2 25 per day	90 00	15 15	105 15
John Rourke	Laborer	92	2 25 per day	207 00	43 64	250 64
						$48,874 03
Incidental expenses.						
Livery						2,942 00
Labor						6,828 31
Stationery						1,299 65
Rent						535 84
Telegraph, telephone and postage						159 81
Fuel and light						29 23
Miscellaneous						1,553 69
Buffalo Engineering Company, preparing plans for Lockport locks						5,000 00
Dutton Pneumatic Lock and Engineering Company, preparing plans for Lockport locks						6,000 00
Stowell & Cunningham, preparing plans for Lockport locks						3,000 00
Thomas Dark & Sons, borings for Lockport locks						1,830 77
						$78,053 33

Extraordinary Repairs—Tonawanda and Amherst Ditches.

Chapter 19, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. T. Jones	Resident engineer	21	$2,000 00 per year	$114 13	....	$114 13
M. W. Wilbur	First assistant engineer	12	6 00 per day	72 00	$6 99	78 99
W. L. Curtis	Assistant engineer	42½	5 00 per day	212 50	115 19	327 69
H. A. Van Alstyne	Assistant engineer	10	5 00 per day	50 00	10 79	60 79
L. B. Fitch	Leveler	18	4 50 per day	81 00	12 37	93 37
C. H. Flanigan	Leveler	10	4 50 per day	45 00	5 64	50 64
D. D. Waldo	Leveler	10	4 50 per day	45 00	....	45 00
J. B. Barrett	Rodman	4	3 50 per day	14 00	80	14 80
F. Mauerman	Chainman	12	2 50 per day	30 00	2 38	32 38
James Thomson	Chainman	10	2 50 per day	25 00	6 09	31 09
R. T. Webster	Chainman	10	2 50 per day	25 00	13 12	38 12
William Schneider	Chainman	10	2 50 per day	25 00	....	25 00
John Pinkel	Chainman	10	2 50 per day	25 00	....	25 00
Walter Dubey	Chainman	10	2 50 per day	25 00	....	25 00
						$962 00
Incidental expenses.						
Miscellaneous						38 00
						$1,000 00

Extraordinary Repairs—Bridge at Falls Creek, Montour Falls.

Chapter 57, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
F. H. Cratts	Leveler	19	$4 50 per day	$85 50	$13 15	$98 65
F. W. Hamilton	Rodman	20	3 50 per day	70 00	2 42	72 42
						$171 07
Incidental expenses.						
Charles F. Stowell, preparing plans						34 58
						$205 65

Extraordinary Repairs — Mill Street Bridge, Buffalo.

Chapter 18, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Carl L. Lund	Leveler	62	$4 50 per day	$279 00	$17 96	$296 96
Henry Geck	Chainman	19½	2 50 per day	48 75	49	49 24
						$346 20
Incidental expenses.						
Charles F. Stowell, inspection						77 70
Miscellaneous						73 90
						$497 80

Extraordinary Repairs — Dyke at Corning.

Chapter 221, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	Assistant engineer in charge	5	$6 00 per day	$30 00	$39 96	$69 96
H. A. Van Alstyne	Assistant engineer	15	5 00 per day	75 00	13 89	88 89
H. A Van Alstyne	Leveler	17	4 50 per day	76 50	60 75	137 25
James Thomson	Rodman	26	3 50 per day	91 00	13 58	104 58
James Thomson	Chainman	29	2 50 per day	72 50	5 01	77 51
						$478 19
Incidental expenses.						
Miscellaneous						12 18
						$490 87

Extraordinary Repairs — Erie Basin and Docks, Buffalo.

Chapter 224, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
L. B. Fitch	Leveler	33	$4 50 per day	$148 50	$0 22	$148 72
Walter Dubey	Chainman	79	2 50 per day	197 50	45	197 95
						$346 67
Incidental expenses.						
Miscellaneous						20 00
						$366 67

Extraordinary Repairs — Deepening and Improving Mud Creek.

Chapter 307, Laws of 1895, and Chapter 477, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. T. Jones	Resident engineer	49½	$2,000 00 per year	$270 30	$139 97	$410 27
H. A. Van Alstyne	Assistant engineer	26	5 00 per day	130 00	13 93	143 93
E. R. Payne	Rodman	26	3 50 per day	91 00	2 50	93 50
J. B. Barrett	Rodman	5	3 50 per day	17 50	10 73	28 23
A. W. Peters	Chainman	26	2 50 per day	65 00	2 00	67 00
F. Mauerman	Chainman	5	2 50 per day	12 50	9 00	21 50
						$764 43
Incidental expenses.						
Livery						58 00
Office rent						12 50
						$834 93

Extraordinary Repairs—Dredging Lower Black Rock Harbor.

Chapter 320, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	21	$5 00 per day	$105 00	$59 08	$164 08
L. B. Fitch	Leveler	35	4 50 per day	157 50	15 75	173 25
Charles G. Douw	Rodman	26	3 50 per day	91 00	2 98	93 98
F. Mauerman	Chainman	40	2 50 per day	100 00	....	100 00
John Pinkel	Chainman	34	2 50 per day	85 00	....	85 00
						$616 26

Extraordinary Repairs — Main Street Bridge, Fairport.

Chapter 576, *Laws of* 1894, *and Chapter* 151, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	108	$5 00 per day	$540 00	$86 86	$626 86
L. B. Fitch	Leveler	3	4 50 per day	13 50	2 80	16 30
J. B. Barrett	Rodman	74	3 50 per day	259 00	11 06	270 06
						$913 22
Incidental expenses.						
Charles F. Stowell, inspection						110 00
						$1,023 22

Extraordinary Repairs — Improving Catharine Creek, Montour Falls.

Chapter 453, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
A. T. Jones	Resident engineer	4	$2,000 00 per year	$21 74	$14 64	$36 38
C. H. Flanigan	Leveler	26	4 50 per day	117 00	9 86	126 86
H. A. Van Alstyne	Leveler	4	4 50 per day	18 00	7 04	25 04
James Thomson	Chainman	8	2 50 per day	20 00	15 63	35 63
						$223 91
Incidental expenses.						
Postage and stationery						48 09
						$272 00

Extraordinary Repairs — Dredging Ohio Basin, Buffalo.

Chapter 145, Laws of 1894.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	79	$4 50 per day	$355 50	$23 82	$379 32
J. B. Barrett	Rodman	15	3 50 per day	52 50	33 76	86 26
Wm. Schneider	Chainman	79	2 50 per day	197 50	1 85	199 35
F. Mauerman	Chainman	32	2 50 per day	80 00	45	80 45
						$745 38
Incidental expenses.						
Fuel and office rent						39 75
American Engineering and Inspection Association						78 89
						$864 02

Extraordinary Repairs — Main Street Bridge, Newark.

Chapter 217, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Charles G. Douw	Rodman	115	$3 50 per day	$402 50	$6 55	$409 05
Henry Geck	Chainman	6	2 50 per day	15 00	....	15 00
						$424 05
Incidental expenses.						
Rochester bridge and iron works, plans						150 00
Stowell & Cunningham, inspection						72 50
						$646 55

Extraordinary Repairs—Bull Creek Improvement.

Chapter 547, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
D. D. Waldo	Leveler	26	$4 50 per day	$117 00	$18 91	$135 91
L. B. Fitch	Leveler	64	4 50 per day	288 00	22 45	310 45
F. Mauerman	Chainman	53	2 50 per day	132 50	4 94	137 44
Total						$583 80

Extraordinary Repairs—Porter Avenue Bridge, Buffalo.

Chapter 590, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
C. T. Middlebrook, Jr.	Assistant engineer	52	$5 00 per day	$260 00	$34 43	$294 43
E. A. Sommer	Leveler	79	4 50 per day	355 50	7 29	362 79
Avery H. Wilcox	Chainman	71	2 50 per day	177 50	....	177 50
						$834 72
Incidental expenses.						
Buffalo Engineering Company, plans						1,654 07
Thomas Dark & Sons, test borings						202 20
Office rent						5 60
Miscellaneous						10 00
						$2,706 59

Extraordinary Repairs—Sewer at Horseheads.

Chapter 679, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	First assistant engineer	24	$6 00 per day	$144 00	$121 78	$265 78
H. A. Van Alstyne	Leveler	9	4 50 per day	40 50	9 88	50 38
James Thomson	Chainman	3	2 50 per day	7 50	2 40	9 90
John O'Conner	Chainman	31	2 50 per day	77 50	14 47	91 97
						$418 03
Incidental expenses.						
Labor						64 35
Office rent						12 00
Postage and telegraph						2 87
						$497 25

Extraordinary Repairs — Chemung Canal at Horseheads.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. A. Van Alstyne	Leveler	10	$4 50 per day	$45 00	$6 46	$51 46
James Thomson	Chainman	27	2 50 per day	67 50	79	68 29
John Rourke	Chainman	18	2 50 per day	45 00	18 71	63 71
						$183 46
Incidental expenses.						
Miscellaneous						16 54
						$200 00

Extraordinary Repairs — West Main Street Lift Bridge, Rochester.

Chapter 652, *Laws of* 1894.

INCIDENTAL EXPENSES.

Stationery $60 00

Extraordinary Repairs — Pendleton Culvert.

Chapter 17, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
J. B. Barrett	Rodman	6	$3 50 per day	$21 00	$8 20	$29 20

Extraordinary Repairs — Divens Ditch and Culvert.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. A. Van Alstyne	Leveler	12	$4 50 per day	$54 00	$1 47	$55 47
John Rourke	Chainman	29	2 50 per day	72 50	15 55	88 05
						$143 52
Incidental expenses.						
Livery						16 50
						$160 02

Extraordinary Repairs — Chemung River Bridge Abutments.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
H. A. Van Alstyne	Leveler	16	$4 50 per day	$72 00	$9 70	$81 70
James Thomson	Chainman	14	2 50 per day	35 00	10	35 10
						$116 80

Incidental expenses.

Livery	10 00
	$126 80

Extraordinary Repairs — Repairs to Roads and Bridges at Versailles, Cattaraugus Indian Reservation.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	4¼	$5 00 per day	$21 25	$8 10	$29 85
Incidental expenses.						
Miscellaneous						121 75
Stationery						48 90
						$200 00

Extraordinary Repairs — Repairs to Highways at Redhouse, Allegany Indian Reservation.

Chapter 932, Laws of 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	8½	\$5 00 per day	\$42 50	\$31 94	\$74 44
J. B. Barrett	Rodman	26	3 50 per day	91 00	12 06	103 06
						\$177 50
Incidental expenses.						
Miscellaneous						22 50
						\$200 00

Extraordinary Repairs—Glen Creek, Watkins.

Chapter 140, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
M. W. Wilbur	Leveler	16	$5 00 per day	$80 00	$4 08	$84 08
C. H. Flanigan	Leveler	40	4 50 per day	180 00	48 56	228 56
						$312 64
Incidental expenses.						
Stationery						4 50
Miscellaneous						110 60
						$427 14

Extraordinary Repairs—Repairs to Bridge at Irving, Cattaraugus Indian Reservation.

Chapter 932, *Laws of* 1895.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
W. L. Curtis	Assistant engineer	20¾	$5 00 per day	$103 75	$31 25	$135 00
Henry Geck	Chainman	26	2 50 per day	65 00	....	65 00
						$200 00

Extraordinary Repairs—Removing Porter Avenue Bridge to Jersey Street, Buffalo.

Chapter 668, Laws of 1894, and Chapter 482, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Avery H. Wilcox	Chainman	8	$2 50 per day	$20 00	$2 15	$22 15
Incidental expenses.						
Rochester Bridge and Iron Works						20 20
						$42 15

Extraordinary Repairs — Dredging Seneca Lake Level, Chemung Canal.

Chapter 572, Laws of 1894, and Chapter 482, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Charles E. Whitcher	Chainman	61	$2 50 per day	$152 50	$8 78	$161 28

Extraordinary Repairs — Scott Street Bridge, Buffalo.

Chapter 947, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Irving Hawkins	Rodman	61	$3 50 per day	$213 50	$5 47	$218 97

Extraordinary Repairs — Survey Newtown Creek.

Chapter 949, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
John R. Kaley	First assistant engineer	6	$6 00 per day	$36 00	$38 90	$74 90
H. P. Gillette	Assistant engineer	88	5 00 per day	440 00	76 40	516 40
James Thomson	Rodman	74	3 50 per day	259 00	40 92	299 92
John O'Conner	Chainman	36	2 50 per day	90 00	28 15	118 15
						$1,009 37
Incidental expenses.						
Labor						267 25
						$1,276 62

Extraordinary Repairs—Repairing Highways from Lawtons to Versailles, Cattaraugus Indian Reservation.

Chapter 949, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
L. B. Fitch	Leveler	11	$4 50 per day	$49 50	$11 75	$61 25
F. Mauerman	Chainman	11	2 50 per day	27 50	5 02	32 52
Total						$93 77

Extraordinary Repairs—Dredging and Removing Obstructions in Findley's Lake.

Chapter 950, *Laws of* 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
Charles E. Whitcher	Chainman	18	$2 50 per day	$45 00	$6 23	$51 23

Extraordinary Repairs—Exchange Street Bridge, Rochester.

Chapter 514, *Laws of* 1895.

George P. Hilton, preparing plans	$750 00

Extraordinary Repairs — Genesee River Storage Survey.

Chapter 950, Laws of 1896.

NAME.	Rank.	Number of days.	Rate of compensation.	Salary.	Travel.	Total.
George W. Rafter	Assistant engineer in charge	68	$10 00 per day	$680 00	$354 50	$1,034 50
W. Greenalch	Assistant engineer	77	5 00 per day	385 00	34 52	419 52
Wm. Grennell, Jr.	Leveler	47	4 50 per day	211 50	2 49	213 99
H. C. Copeland	Rodman	31	3 50 per day	108 50	9 43	117 93
H. G. McKelvey	Draughtsman	6	3 50 per day	21 00	....	21 00
R. W. Swanton	Chainman	75	2 50 per day	187 50	2 10	189 60
						$1,996 54
Incidental expenses.						
Livery					$313 60	
Labor					1,827 18	
Stationery					26 30	
Postage and telegraph					19 59	
Office rent					20 00	
Miscellaneous					1,271 53	
Seth Bills, building dam					500 00	
Sullivan Machinery Company (diamond drill)					650 24	
C. R. Parsons, lumber					545 31	
Genesee Valley Manufacturing Company, hardware					133 42	
E. B. Osborne, hardware					98 00	
						5,405 17
						$7,401 71

Summary of Engineering Expenses upon the Western Division, New York State Canals, for the fiscal year ending September 30, 1896.

EXTRAORDINARY REPAIRS.	Authorized by		Amount.
	Chap.	Laws.	
Dredging Ohio basin, Buffalo	145	1894	$864 02
Dredging Seneca lake level, Chemung canal	572 482	1894 1896	161 28
Main street bridge, Fairport	576 151	1894 1895	1,028 22
West Main street bridge, Rochester	652	1894	60 00
Pendleton culvert	17	1895	29 20
Mill street bridge, Buffalo	18	1895	497 80
Tonawanda and Amherst ditches	19	1895	1,000 00
Bridge at Falls creek, Montour Falls	57	1895	205 65
Canal improvement	79	1895	78,053 33
Glen creek, Watkins	140	1895	427 14
Main street bridge, Newark	217	1895	646 55
Dyke at Corning	221	1895	490 37
Erie basin and docks, Buffalo	224	1895	866 67
Repairing and improving Mud creek	307 477	1895 1896	834 93
Dredging lower Black Rock harbor	320	1895	616 26
Improving Catharine creek, Montour Falls	453	1895	272 00
Exchange street bridge, Rochester	514	1895	750 00
Bull creek improvement	547	1895	583 80
Porter avenue bridge, Buffalo	590	1895	2,706 59
Sewer at Horseheads	679	1895	497 25
Repairs to Chemung canal at Horseheads	932	1895	200 00
Divens ditch and culvert	932	1895	160 02
Chemung river bridge abutments	932	1895	126 80
Repairs to roads and bridges at Versailles	932	1895	200 00
Repairs to highways at Redhouse	932	1895	200 00
Repairs to bridge at Irving	932	1895	200 00
Removing Porter avenue bridge to Jersey street, Buffalo	482	1896	42 15
Scott street bridge, Buffalo	947	1896	218 97
Survey Newtown creek	949	1896	1,276 62
Repairing highways from Lawtons to Versailles	949	1896	93 77
Dredging and removing obstructions in Findley's lake	950	1896	51 28
Genesee river storage survey	950	1896	7,401 71
Ordinary repairs	282	1895	9,974 62
Total	......	......	$110,231 95

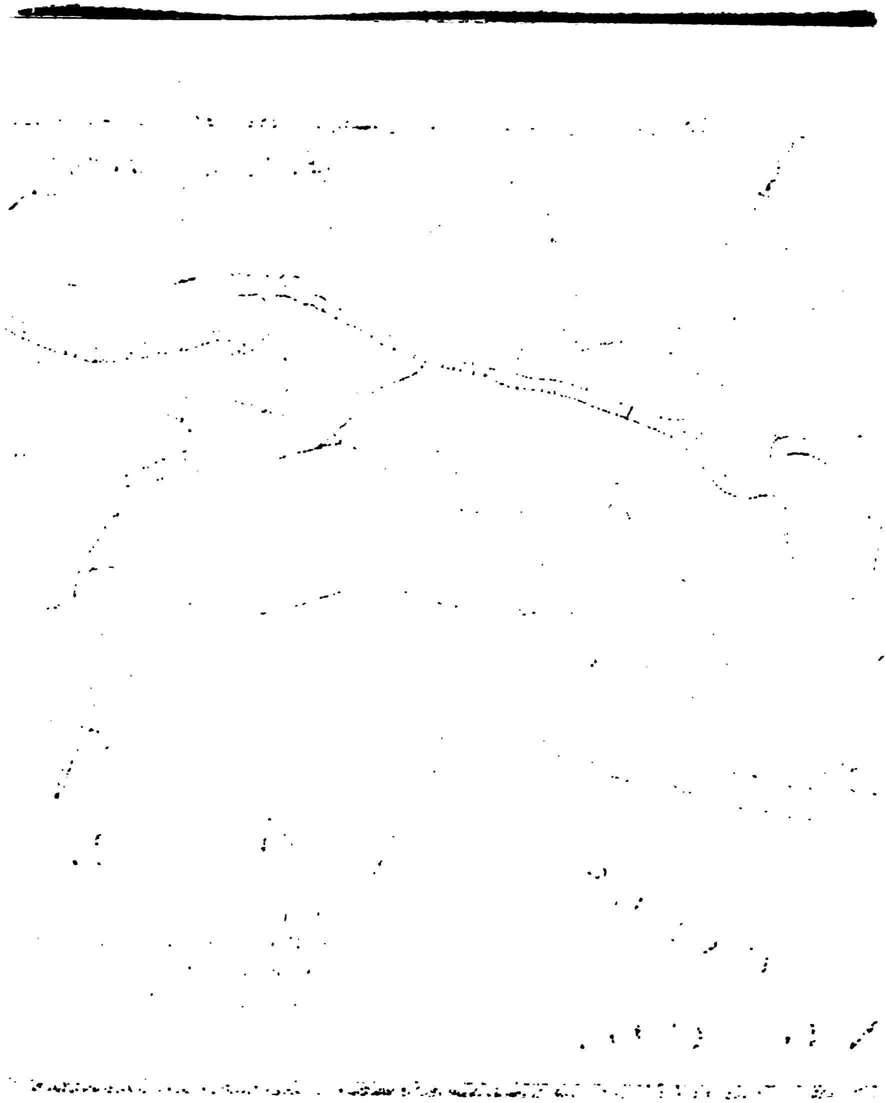
APPENDIX VII.

REPORT

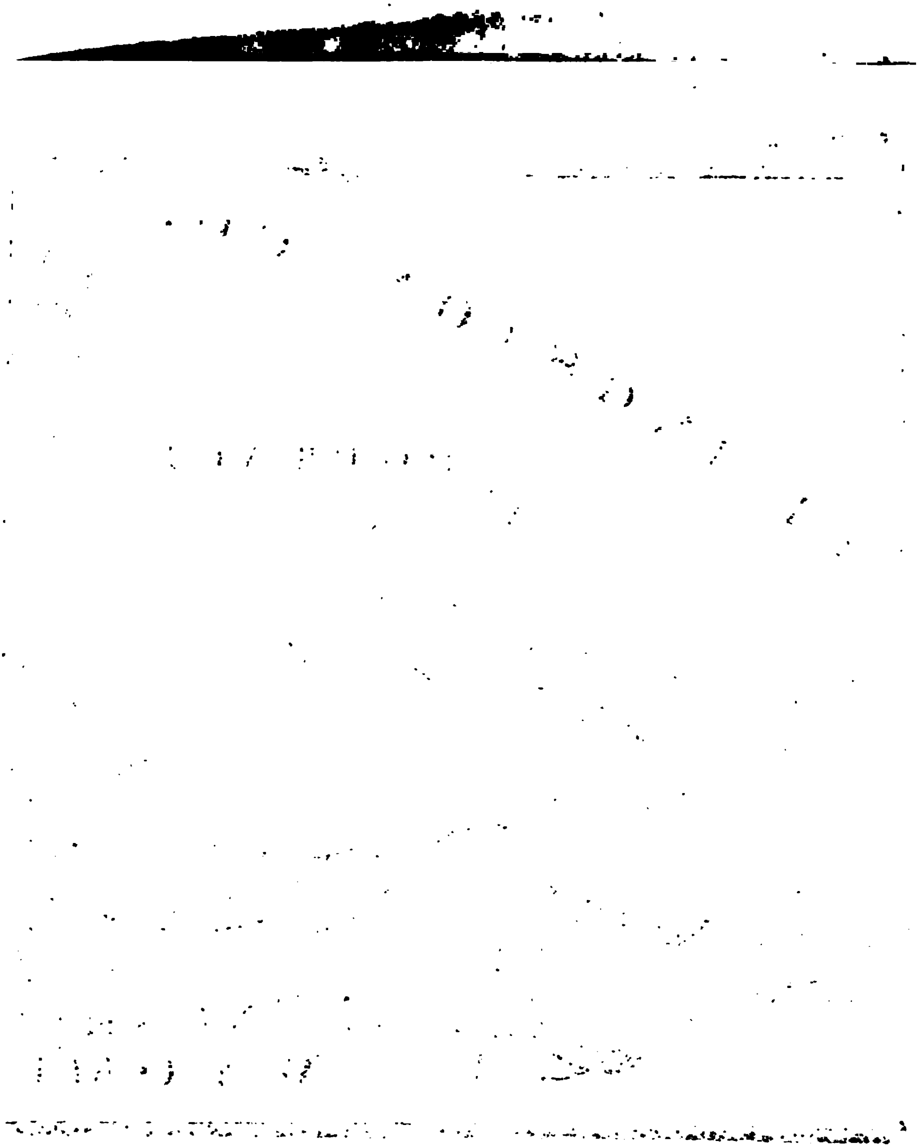
ON

GENESEE RIVER STORAGE.

By Geo. W. Rafter.



a dam on the Genesee river, leaving the question of location of dam entirely open. It also provided the sum of $10,000 for further investigations as to best site, the actual location only to be made after such additional investigation.



REPORT.

ALBANY, N. Y., *January* 1, 1897.

Hon. CAMPBELL W. ADAMS, *State Engineer and Surveyor:*

Sir.— I have the honor to report as follows relative to the work done on the Genesee river storage project during the summer of 1896. This season's work has been performed under the provisions of an item in the Supply Bill, Chapter 950 of the Laws of 1896, wherein is provided the sum of $10,000 for further investigation of foundation of proposed dam at Mount Morris, and of the best means of transportation of material to its site, and for detailed plans.

In regard to the provision of the clause of the Supply Bill as to further investigation of dam at Mount Morris, it may be stated, that by reason of the work thus far performed having all been on the proposed site at Mount Morris, the idea had become prevalent that the possibilities of storage on the Genesee river had been exhausted by the surveys made in previous years, and no other site could be obtained as satisfactory as the Mount Morris site. This misunderstanding as to the real facts of the case led to the insertion of the clause of the Supply Bill in the manner indicated.

VIEWS OF THE ENGINEERING DEPARTMENT.

It may be noted, however, that the Act passed by the Legislature at the 1895 Session, but which did not receive the Governor's approval, provided for an appropriation for the construction of a dam on the Genesee river, leaving the question of location of dam entirely open. It also provided the sum of $10,000 for further investigations as to best site, the actual location only to be made after such additional investigation.

This matter is referred to by way of showing that the Engineering Department, at any rate, had not considered the question of site definitely settled.

THE LIMITATION OF THE INVESTIGATION TO MOUNT MORRIS A TECHNICAL ERROR.

After the passage of Act, Chapter 950, and its approval by the Governor, the discovery was made that the provision in question apparently limited the additional investigation to the site formerly considered at Mount Morris. On second thought, however, it appeared clear that this was a technical error which had no significance; that the object of the additional appropriation was to determine the best possible site, if any better existed, and really there was no reason why a portion of it should not be used for such additional studies as the Honorable State Engineer and Surveyor might deem necessary. This view of the case was referred to the Honorable Comptroller, and, his assent having been obtained, it was decided to investigate further sites by way of determining whether the storage could not be made cheaper than at Mount Morris, the provisional determination having been made in the meantime that a site above the Upper falls at Portage probably possessed decided advantages over the sites previously studied at Mount Morris.*

*By way of presenting the previous work on the Genesee Storage, reference may be made to the special report of the Hon. John Bogart, State Engineer and Surveyor, as found in Appendix F of the Annual Report of the State Engineer and Surveyor, for the fiscal year ending September 30, 1890. The reports of Messrs. Bailey and Kibbe, Assistant Engineers to Mr. Bogart, are covered by the same reference. The Report of the Hon. Martin Schenck, State Engineer and Surveyor, may be found at page 44 of the Annual Report of the State Engineer and Surveyor, for the fiscal year ending September 30, 1893. The report of Hon. E. Sweet, ex-State Engineer and Surveyor, as Consulting Engineer, may be found in Appendix H of the Annual Report of the State Engineer and Surveyor, for the fiscal year ending September 30, 1893. The Report of the Commissioners appointed in 1892 by Governor Flower may be found in Senate Documents of 1893. The first Report of the present writer may be found in Appendix G of the Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1893. The second report may be found in Appendix E of the Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1894. Also, see paper by the present writer, The Genesee River Storage and Its Relations to the Erie Canal and the Manufacturing Interests of Western New York, as prepared for the Rochester Chamber of Commerce. This paper contains a large amount of historical information not given in the official reports. The foregoing includes all the information in regard to Genesee Storage previous to the present Report.

PREVIOUS WORK ON THE GENESEE STORAGE PROJECT.

It may be noted that all the work accomplished by Mr. Bogart in 1890 was general in its character. It was carried on more particularly with reference to the selection of the best site in the canyon of the Genesee river between Mount Morris and the foot of the Portage falls. No detail surveys were made, although Mr. Bogart states that a dam 58 feet in height, which would store 1,500,000,000 cubic feet (the amount which he considered necessary for canal purposes), could be erected for perhaps $1,000,000. Further than this, so far as can be learned either from the report or from the office records, no detailed estimates were made by the Department at that time.*

TABLE No. 1.

Showing the flow of the Genesee River at Mount Morris in cubic feet per second.

(Drainage area at Mount Morris, 1,070 square miles.)

MONTH.	1893.	1894.	1895.	1896.	Remarks.
December†	......	2,170	568	1,226	
January	......	1,297	604	436	
February	......	884	224	907	
March	......	3,074	1,803	2 786	From September, 1893, to January, 1895, inclusive, the original flows as given on the diagrams in the report of April 1, 1894, have been corrected as follows: For mean monthly flows of less than 1,000 cubic feet per second 5 per cent. has been deducted; over 1,000 cubic feet per second and less than 3,000, 10 per cent. deduction; above 3,000 cubic feet per second, 5 per cent. has been deducted. These corrections have been indicated by the results of the weir measurements made in the summer and fall of 1896.
April	......	3,245	1,927	3,245	
May	......	4,108	174	157	
Mean	......	2,485	886	1,456	
June	......	1,050	128	296	
July	......	132	105	226	
August	......	200	115	188	
Mean	......	454	116	236	
September	314	888	100	148	
October	356	407	104	1,664	
November	516	782	449	782	
Mean	395	689	216	874	
Yearly mean	......	1,525	526	1,005	

While Mr. Bogart did not submit any estimates showing the cost of high dams on the Genesee river, the opinion is still expressed

*See Annual Report of State Engineer and Surveyor for fiscal year ending September 30, 1890, for the estimate referred to.

† In all of the following tables the water year is considered as beginning with the month of December and ending with November. Thus the water year of 1893 extends from December, 1892, to November, 1893, inclusive.

in his report* that the opportunity for forming an artificial reservoir of great dimensions exists in the Mount Morris canyon under remarkably favorable circumstances.

THE INVESTIGATIONS IN 1893.

The work performed under the direction of the present writer in 1893 was of an entirely different character from that performed in 1890. The report of 1890 having indicated the Mount Morris canyon as the preferable location, with a number of sites pointed out of which general investigations had been made, it then became desirable to investigate those sites in detail and prepare close estimates of the cost of constructing dams at each. At the beginning of the study it became evident that Sites 3 and 4 might be considered unworthy of special consideration by reason of the small storage to be gained. The detail work was, therefore, narrowed to Sites 1 and 2, as defined by Mr. Bogart, together with an additional site known as the Hogback location. Detailed investigations were made of these three sites, the results of which may be found in the Reports of 1893 and 1894, where estimates of the costs of the several dams in detail may also be found. It will be understood that the work of 1893 was all done with reference to determining the relative value of the several locations in the Genesee canyon at or near Mount Morris.

CONCLUSIONS REACHED IN 1890.

As already stated, the general conclusion reached in 1890 was that a location in the narrow Mount Morris canyon would be preferable to any other on the Genesee river. Probably the principal reason for this conclusion was the low cost of the lands to be flooded. As shown by Plates I and II, the Mount Morris canyon is deep and narrow, with steep slopes at the sides, and while the flat lands through which the river flows, alternating from side to side, are generally fertile, still their location at the bottom of this deep gorge renders them practically inaccessible, and hence of low

*See 1890 Report, page 420.

value. The estimates as given in the 1894 report place a value upon the 2,620 acres of land required for a dam storing 7,500,000,000 cubic feet, of only $78,600, and it is believed that this sum would be ample for the amount of land required at that point. By reason of deep and expensive foundations for the dam, the entire reservoir is found, however, to cost $2,785,000. Hence it appears that at Mount Morris practically the entire expenditure is for the dam — $78,600, the estimated cost of the land to be flooded, is so small a portion of the whole that it may be in effect left out of the account. It appears clear, therefore, that the low cost of the land to be taken had in some way obscured the real question at issue, thus leading to the selection of a site which the work of this year has shown to be, even though the land is cheap, a relatively very expensive one.

TABLE No. 2.

Showing the flow of the Genesee river at Mount Morris, in inches, on the watershed.

(Drainage area at Mount Morris, 1,070 square miles).

MONTH.	1893.	1894.	1895.	1896.	Remarks.
December	......	2 34	0.61	1.82	
January	......	1.40	0.66	0.47	
February	......	0.86	0.22	0.91	
March	......	3.31	1.94	3.00	
April	......	8.39	2.01	3 38	
May	......	4.43	0.19	0.17	
Total	......	15.73	5.63	9.25	
June	......	1.10	0.13	0 39	For the monthly flows of this table in mean cubic feet per second, see Table No. 1.
July	......	0.14	0.11	0.24	
August	......	0.22	0.12	0.20	
Total	......	1.46	0.36	0.83	
September	0.33	0.93	0.10	0.16	
October	0.38	0.44	0.11	1 74	
November	0.54	0.82	0.47	0.82	
Total	1.25	2.19	0.68	2 72	
Total for year	......	19.38	6.67	12.80	

THE STEPS TO BE TAKEN IN STORAGE PROJECTS.

In view of the fact that large storage projects are now extensively agitated in this State, and are likely to require considerable attention from the State Engineer's Department for the next few

years, it is deemed proper to saliently point out that there are certain steps to be taken in the formulation of such a project which cannot be safely neglected. In the first place, we need to know in any given case the topography of the entire river valley thoroughly, for which purpose the topographical survey of the State should, in the writer's opinion, be pressed to an immediate conclusion in order to furnish this part of the necessary information in full detail. Secondly, we need to know the runoff of the stream in comparison with the rainfall and mean temperature of the locality for a series of years. For this purpose there should be obtained as soon as possible a series of gagings of the principal streams of the State, together with the necessary meteorological observations.* The greater the length of time covered by such records the more value they have. In any case, we ought not to begin the construction of a large storage project until we have at least five years' record of the runoff of the stream in comparison with the meteorological data. And ten years would be much better. By keeping such records we may hope, in the course of time, to learn the full value of the rivers of New York as a part of the material resources of the State.

We may conclude then that a storage project such as that now under consideration is a special problem which may be stated in general terms as follows: Given a river of known drainage area, the rainfall on the drainage area and the runoff, it is required to find either the maximum storage available for complete regulation, or the practicable storage, together with the effect of the same on the various interests involved whatever they may be. The available data for such solution are (1) the rainfall and other meteorological records; and (2) the runoff record as determined by gagings of the stream.

THE STATE NEEDS STREAM FLOW INVESTIGATION.

In discussing this phase of the question, it may be proper to say that the present writer has no intention of reflecting in any way,

*The State Weather Bureau has kept meteorological records at a number of places since 1889. The difficulty with the records of this bureau is that the observers are voluntary and very few complete records have been obtained. The observers should be paid enough to insure the continuity of the work.

shape or manner on the previous work of the Department. If there is any reflection it is upon the general policy of the State in not beginning such a series of gaging of the leading streams many years ago. Indeed it is astonishing, considering the amount of money which the State of New York has invested in its canal system, and which depends upon the flow of the various streams of the State to supply it with water, that, previous to the last two or three years almost absolutely nothing has been done in the way of gaining this important information. There is no State in the Union where information of the kind indicated has been as necessary as in New York, and yet thus far New York State has done nearly nothing in the way of obtaining it.* It is even behind a number of the other States where a knowledge of stream flow has been recognized as important, and detailed observations have been made covering the point now under discussion.†

By way of illustrating the foregoing propositions, it may be pointed out that in the absence of special information applying to the streams of our own State, Mr. Bogart could only use, in such studies as he made in 1890, general data largely derived from gagings of streams abroad.‡ Working from such data, it was concluded that, as a mean a run-off of about 12.3 inches on the watershed might be expected at Mount Morris in an average year.§ As may be seen, Mr. Kibbe shows by his tables the possibility of a collection of only 6.27 inches in a minimum year, although 12.3 inches has apparently been considered the quantity which might reasonably be expected. The whole matter illustrates the danger

*The writer of course does not overlook the work of John B. Jervis in gaging the Eaton and Madison brooks in 1835. The gagings were, however, only of the flow of two small drainage areas and merely extended over two seasons.

†As for instance in Maine where such studies were made about 20 years ago and which have been of great use in leading to the development of water power in that State. Also, in New Jersey where a study of stream flow was completed in 1894.

‡The Sudbury river gagings in Massachusetts and the Croton in this State had been only slightly considered by engineers in 1890.

§See Appendix F of Annual Report of State Engineer and Surveyor for the fiscal year ending September 30, 1890, page 422. Mr. Bogart points out, however, that the amount of water flowing in the Genesee river through a long series of years could only be absolutely ascertained by measurement of such flow for many years. Also, see tables accompanying the report of Mr. Kibbie, facing page 456 of the same report. Also, see page 454 of that report.

of applying averages to questions of stream flow. Further, by way of showing how impossible it is to arrive at safe conclusions regarding the flow of streams in any other way than by actual gagings, it may be pointed out that the present writer, when preparing his final report* on the Genesee storage project, in the

TABLE No. 3.

Showing the proportional flow of the Genesee River at Portage, in cubic feet per second.

(Drainage area at Portage, 1,000 square miles.)

MONTH.	1893.	1894.	1895.	1896.	Remarks.
December	......	2,028	531	1,146	
January	......	1,212	565	408	
February	......	826	209	848	
March	......	2,873	1,684	2,604	
April	......	3,033	1,800	3,033	
May	......	3,839	163	147	
Mean	......	2,316	828	1,361	
June	......	981	120	277	For inches on the watershed as derived from Mount Morris gagings see Table No. 2.
July	......	123	98	211	
August	......	187	108	176	
Mean	......	424	109	221	
September	294	830	93	138	
October	333	380	97	1,556	
November	482	731	420	731	
Mean	369	644	202	817	
Yearly mean	......	1,429	492	939	

spring of 1894, made a careful study of the meteorological data available at that time, with the result of arriving at the conclusion that, for the Upper Genesee drainage area, the minimum runoff might be expected to reach 10.60 inches on the watershed, although, probably, for the area at Rochester, by reason of less rainfall on the catchment area of the lower river, the runoff would not exceed 8.5 inches in a minimum year. One of the first things done in connection with the survey work of 1893 was to establish a series of gagings of the daily flow of the Genesee river at Mount Morris, which have been kept up from September 1 of that year to the present time. From these gagings we learn that in the

*See Annual Report State Engineer and Surveyor for fiscal year ending September 30, 1894, Appendix E. Table No. 7, facing page 376.

water year of 1895 (December, 1894, to November, 1895, inclusive), the runoff of the Genesee river at Mount Morris was only 6.67 inches in the watershed. The detail of these gagings may be found in Tables Nos. 1 and 2. The writer cites this computation of his own by way of showing that, in discussing the misapprehensions as to Genesee storage, which have arisen by reason of inadequate data, there is no intention of reflecting on the former work of the Department. If there is any reflection, it is on his own work as well as that of others.

ERRONEOUS VIEWS OF GENESEE STORAGE.

Continuing the discussion on this line, it may be further remarked that, while Mr. Bogart did not actually say, in his report of 1890, that a runoff of 12.3 inches might be expected in a year of minimum flow, still in some way that figure has been tacitly accepted, especially in Rochester, where great interest in the Genesee storage project has been manifested because of the incidental benefits to the water power to be realized there. On this basis the conclusion has been drawn that a total storage in the Mount Morris canyon of 7,370,000,000 cubic feet would supply the needs of the Erie canal and furnish about 30,000 horse power continuously, or, in other words, would ensure a minimum flow of about 1,400 cubic feet per second. Nearly all discussion of the Genesee storage project for the last six years has proceeded on the basis that the proposed dam at Mount Morris, storing 7,370,000,000 cubic feet, would produce substantially this result. The year 1895, however, was an exceedingly dry year, not only in Western New York, but in a large portion of the Eastern United States. Streams generally ran very low that year. As already indicated, the Mount Morris gagings indicate a total flow for the water year of 1895 of only 6.67 inches, while at Rochester, with 2.2 times the catchment, the flow probably did not exceed about 6.41 inches*

*As is shown by the meteorological records the rainfall of the Lower Genesee area was less in 1895 than that of the Upper.

RECENT ADVANCES IN METHODS OF TREATING STREAM FLOW.

As further modifying the implication that the great discrepancy between the results of computation and of actual observation can be considered as in any way reflecting on the engineering skill of those concerned in former years with Genesee storage, it may be remarked that since 1890 very great advances have been made in methods of treating questions of stream flow and their application to river regulation in the manner proposed on the Genesee. At the present time we may consider questions of stream flow and river regulation as upon an entirely different basis from what they were in 1890.*

TABLE No. 4.

Showing proportional flow of the Genesee River at Rochester in cubic feet per second.

(Drainage area at Rochester, 2,365 square miles.)

MONTH.	1893.	1894.	1895.	1896.	Remarks.
December	......	1,797	1,256	2,710	
January	......	2,867	1,835	964	
February	......	1,954	495	2,005	
March	......	6,794	3,985	6,158	
April	......	7,172	4,257	7,172	
May	......	9,080	385	847	
Mean	......	5,477	1,958	3,218	
June	......	2,321	283	654	
July	......	292	232	501	
August	......	442	254	416	For inches on the watershed as derived from the Mount Morris gagings, see Table No. 2.
Mean	......	1,003	256	522	
September	694	1,963	221	327	
October	787	899	230	3,667	
November	1,141	1,729	993	1,728	
ean	873	1,523	478	1,926	
Yearly mean	......	3,370	1,163	2,220	
Inches on watershe d	......	19.38	6.67	12.80	

*See Report on Water Supply, Water Power, the Flow of Streams and Attendant Phenomena. By C. C. Vermeule, Vol. 3 of the Final Report of the State Geologist of New Jersey, 1894.

44

ESTIMATED COST OF THE PROPOSED RESERVOIR IN THE MOUNT MORRIS CANYON.

As indicated on page 628, it appeared desirable before beginning the preparation of detailed plans for a reservoir on the Genesee river to examine an additional site at Portage, just above the upper fall at that place. Before proceeding to a description of the new site, it will be desirable, in order to have the figures at hand for a comparison of the two, to present briefly the estimates made in former reports of the cost of the proposed reservoir in the Mount Morris canyon.* Referring to the figures in detail, it appears that at Site No. 1, a dam raising the water surface 130 feet would cost, if built of concrete alone, $2,450,000, but, if built with sandstone faces throughout, except for the spillway, where granite is provided, the estimated cost would be $2,590,000. A dam of the same height at Site No. 2, if built throughout of concrete would cost $2,600,000, but with sandstone faces and independent spillway, the cost would be $2,720,000. These estimates are for a plain wall without any architectural treatment of any sort or kind. As the result, however, of the final studies, it is considered desirable to give the dam some limited adornment in the way of architectural treatment. Estimating such work at $100,000, we have that amount to be added to the estimates just cited in order to place the Mount Morris project on the same basis as that which has been used in preparing the design at Portage.

Again no decision was ever made as to just the location for the dam at Mount Morris, whether it should be at Site No. 1 or Site No. 2. By way of comparison we may, therefore, take a mean of the estimated costs of these sites. We have then:

Estimated cost of Site No. 1 without architectural adornment	$2,590,000 00
Add for architecture	100,000 00
Total	$2,690,000 00

*See Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1894; Appendix E, p. 664-71 referring to the detailed estimates.

Estimated cost of Site No. 2 without architectural adornment	$2,720,000 00
Add for architecture	100,000 00
Total	$2,820,000 00

The mean of $2,690,000 and $2,820,000 is $2,755,000.

In addition to the architectural adornment, it has also been considered desirable to include in the estimates for the reservoir at Portage the cost of a good wagon road entirely around the reservoir, and in order to make the Mount Morris project fully comparable we should also add for the cost of a similar road there. The object of making this road is to add to the attractiveness of the reservoir as one of the interesting points for tourists in the State. It is considered that such a road can be built for $1,000 per mile, which makes the cost for 30 miles, the distance around the proposed Mount Morris reservoir, $30,000. Adding this sum to the total of $2,755,000 previously obtained, and we have a final total of $2,785,000.

As regards the total storage, a dam at Site No. 1, at Mount Morris, 130 feet in height, will store 7,700,000,000 cubic feet; in the same way, a dam 130 feet high at Site No. 2 will store 7,040,000,000 cubic feet. The mean of these two is 7,370,000,000 cubic feet. We have, therefore, a mean storage in the Mount Morris canyon of 7,370,000,000 cubic feet, costing a total of $2,785,000, or at the rate of $377.88 per million cubic feet stored. We will use these figures in comparing the relative commercial advantages of the two sites.

TABLE No. 5.

A comparison of the gagings of the Genesee River at Rochester with those at Mount Morris, for the water years 1894–1896, *inclusive.*

(In cubic feet per second, and with yearly means also in inches on the watershed.)

MONTH.	1894.			1895.			1896.		
	As per record.	Corrected.	Proportionate to drainage area.	As per record.	Corrected.	Proportionate to drainage area.	As per record.	Corrected.	Proportionate to drainage area.
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
December	3,914	3,914	4,797	1,459	1,100	1,256	1,839	1,700	2,710
January	2,841	2,841	2,867	1,619	1,200	1,335	1,645	1,400	964
February	2,584	2,584	1,954	977	700	495	2,702	2,702	2,005
March	6,008	6,008	6,794	4,035	4,035	3,985	3,725	3,725	6,158
April	5,646	5,646	7,172	3,083	3,083	4,257	7,623	7,623	7,172
May	6,304	6,304	9,080	1,309	900	385	1,576	1,300	347
Mean	4,576	4,576	5,477	2,099	1,848	1,958	3,181	3,054	3,218
June	2,951	2,800	2,321	885	535	283	1,317	1,000	654
July	1,055	792	292	645	390	232	854	645	501
August	973	732	442	660	400	254	585	440	416
Mean	1,656	1,426	1,003	728	440	256	977	692	522
September	1,664	1,500	1,963	407	250	221	324	240	327
October	1,226	920	899	366	220	230	2,271	2,000	3,667
November	1,782	1,600	1,729	834	500	993	993	745	1,728
Mean	1,573	1,335	1,523	534	333	478	1,353	1,006	1,926
Yearly mean	3,088	2,978	3,370	1,364	1,116	1,163	2,174	1,951	2,220
Inches on watershed	19.20	18.35	19.38	8.48	6.41	6.67	12.48	11.20	12.80

FLOODS IN THE GENESEE RIVER.

Great floods have occurred in the Genesee river in 1815, 1835, 1857, 1865 and 1896. At a number of times between 1865 and 1896 the river has also been very high, but at no time since 1865 as severe as in 1896. Beyond the mere fact that a very severe flood occurred in 1815, which overflowed the flats in the valley between Avon and Mount Morris, and the black ash swamp which then covered the area now included in the First and Third wards of the city of Rochester, little is known as to the flood of that year.

The next great flood of which we have record occurred in October, 1835.* Considerable damage was done to the farms in the flats. According to statements made by Harvey Ely, a former citizen of Rochester, the flow of the river in the flood of 1835 amounted

*See Report of F. C. Mills relative to the Genesee Valley Canal. Assembly Document No. 73, 1837, page 69.

to about 36,000 cubic feet per second. This statement is interesting because the flow in the flood of 1865, so far as it can be computed from the data available, was probably not much in excess of that figure, although it may possibly have gone as high as from 40,000 to 42,000 feet per second. In the spring of 1896 the flood also approximated to the same quantity.

In February, 1857, a serious flood occurred in the Genesee river which carried away not only a number of buildings on the north side of the Main street bridge at Rochester, but also undermined the piers of that bridge and even finally swept away the greater part of the old structure. A new bridge was in process of construction at the time.

THE GREAT FLOOD OF 1865.

March, 1865, was a period of general high water throughout Western New York. Long-continued cold weather and a heavy snowfall were followed by a sudden thaw, accompanied by rain, about the middle of March. On the 16th a freshet in the Upper Genesee valley was reported, and on the 17th the water was very high at Rochester, but aside from the usual alarm manifested on such occasions, the situation was not considered specially serious. The river, however, continued to rise during the night of March 17th, until the banks of the Genesee Valley and the Erie canals were overflowed, with the water pouring direct from the river into the canals. The river further rose above its banks until finally nearly the entire central portion of Rochester was under water. The Photographs, Plates III to IX, show the condition of some of the principal streets, as well as the height to which the river rose at that time. During the whole of the 18th and part of March 19th the only means of transportation throughout the entire business portion of Rochester was by boat. The gas supply was cut off early in the disaster, leaving the city in darkness. The New York Central and Hudson River railroad bridge over the river was carried away, and traffic suspended on that railway for several days. The damage to property is stated to have exceeded $1,000,000.*

*The foregoing details of floods in the Genesee river up to and including 1865, have been mostly gleaned from Peck's History of Rochester. The newspapers of the day have also been referred to for particulars of the great flood of 1865.

Rochester newspapers of March, 1865, give detailed accounts of the Genesee flood, from which it is gleaned that the damage must have been very severe, and may have even considerably exceeded $1,000,000.

A severe flood also occurred in the Upper Genesee at Mount Morris in March, 1893, at which time large quantities of ice were left in the streets of the lower portion of that village, as indicated by Plate X.

It is very common for the flats in the vicinity of Mount Morris to be inundated with great destruction of farms and growing crops, as shown by Plates XI and XII. The flats between Mount Morris and Rochester were also inundated May 22-24, 1894, the damage to growing crops at that time amounting to many thousand dollars.

FLOOD OF 1896 NEARLY REACHES THE DANGER LIMIT.

As shown by Plate XIII, the flood of April, 1896, came very near reaching the danger limit, so near, indeed, that it is now the opinion of many thinking citizens of Rochester that the regulation afforded by the proposed storage dam at Mount Morris may not be sufficient to fully protect the city from a repetition of the disaster of 1865. If the river were to again rise to the height attained in that year, the damage would inevitably be several times greater than occurred then.

DIRECT INTEREST OF THE STATE IN GENESEE RIVER FLOODS.

This is a matter in which the State has direct interest. As shown by plates XIV, XV and XVI, the obstructions to the free flow of the Genesee river through the city of Rochester by bridges and the Erie canal aqueduct are very great, and while it is true that the area of the opening of the aqueduct, of 4,309 square feet, is larger than that of one, at any rate, of the city bridges, which is approximately 3,367 square feet, still, the aqueduct was undoubtedly, to some extent, responsible for the disaster of 1865. Plate VIII may be considered a very strong showing on this point. The State's responsibility in 1865 was fixed by the payment of damages on account of the flood of that year.

THE FLOOD COMMISSION OF 1865.

Following the great flood of March, 1865, the Legislature, on May 1, of that year passed an Act appointing Commissioners to inquire into and ascertain the cause or causes of the inundation of the city of Rochester by the waters of the Genesee river in the month of March, 1865, and also to ascertain whether any, and, if any, what, obstructions had been placed in said river which tended to cause or increase the extent of such inundation, and the nature and extent of such obstructions, and what measures, proceedings and remedies were necessary or proper for the purpose of guarding against or preventing a recurrence of such an inundation. The Commissioners appointed under this Act were Addison Gardner, Amos Bronson, Levi A. Ward, George J. Whitney and George E. Mumford. General I. F. Quinby was Engineer to the Commission.

The Commission begins its report by stating that there is no record in the previous history of Rochester of any serious damage from overflows of the river, no former flood having to any important extent spread beyond the banks of the river. In view of this state of things the citizens of Rochester had felt it to be of the highest importance to ascertain the cause of the unprecedented extent of the 1865 flood, and, as far as possible, to guard against its recurrence.

As to the first cause, it is stated, that, by reason of a sudden change of temperature from winter to almost summer heat, an immense body of snow, which had accumulated during the previous winter weather, was suddenly melted and thrown at once into the river channel, within the space of three or four days, instead of occupying a week or more, as in ordinary floods. Secondly, the effect of the flood was increased in consequence of the obstruction to free flow caused by the bridge and embankment of what is now the New York, Lake Erie and Western railway at Avon. The openings in the embankment across the river valley, while adequate for ordinary floods, were entirely too small for the quantity of water flowing in March, 1865. The consequence was that at the time of greatest flow the water stood at least three feet higher on the upper side of the embankment than on the lower side. The em-

bankment finally gave way, thus allowing a large quantity of ponded water to flow suddenly down the river, filling the channel at Rochester beyond its carrying capacity. As a third cause, the Commissioners found that the channel of the river was obstructed through the city of Rochester in such manner as to cause overflows into the Erie and Genesee Valley canals at that place. The remedy suggested is that the waterway through the city be considerably increased.

THE OBSTRUCTION CAUSED BY THE ERIE CANAL AQUEDUCT.

As regards the Erie canal aqueduct, the Commissioners point out that the piers supporting the structure, instead of being built parallel with the stream, run partially across it, thereby materially increasing the amount of the obstruction by so changing the current that at least one-half the river as it passes the aqueduct flows in the direction of the east bank above Main street bridge. The Commissioners also point out that during the flood trunks of trees, logs and timber lodged against the aqueduct and closed a considerable portion of the waterway through the arches. Under these circumstances the flood rose to the copings, standing more than three feet higher on the south side than on the north. The situation is saliently illustrated by Plate VIII. The Commissioners also considered that Main street bridge presented considerable obstruction. In 1865, and for some years previous to that time, more than two-thirds of the eastern arch of the bridge had been closed by the wall of the building on the north side. This obstruction, however, was removed by the action of the flood, the building in question having been carried away. Since then the east opening has been left entirely free.

WATERWAY AREAS.

At the present time the areas of the several openings of the arches of the Erie canal aqueduct at Rochester are as follows:

First opening, east side, 516.6 square feet; second opening, 681.4 square feet; third opening, 625.7 square feet; fourth opening, 641.3

square feet; fifth opening, 615.3 square feet; sixth opening, 625.7 square feet; seventh opening, 552.4 square feet; total, 4,308.3 square feet.

The following are the total openings of the several river bridges: Court street, 5,081 square feet;* Main street, 3,367 square feet; Andrews street, 4,511 square feet; Central avenue, about 4,450 square feet.

It will be noticed that the area at Main street, the first bridge below the aqueduct, is 941 square feet less than that of the Erie canal aqueduct.

The Commissioners also gave some attention to the causes which made the flood of 1865 greater than that of any previous year, and expressed the opinion that the same causes might produce a still greater flood in the future.

DEFORESTATION A CHIEF CAUSE.

As a chief cause, the Commissioners considered that cutting off the forests and clearing up lands were likely to lead to heavier floods from year to year. In view, therefore, of what seemed to the Commissioners a constant source of danger, they arrived at the conclusion that a much larger waterway was imperatively necessary through the city of Rochester.†

The foregoing gives the more important conclusions of this Commission, and we may now pass to a consideration of the effect of deforestation in adding to the intensity of floods.‡

The view that floods are largely increased by deforestation of a drainage area is extremely prevalent, and many important treatises have been written advocating that view. The contrary view has also been expressed by a number of authors. By way of indicating the present state of the evidence, we may briefly refer to some of

* This is the opening of the river arches below the level of the flood of 1865; in addition the arches over the Johnson and Seymour raceway have an opening of 790 square feet and the Erie canal arches of 498 square feet.

† The waterway is still substantially the same as in 1865. If anything it has been somewhat contracted by various constructions since that day.

‡ The Report of the Commissioners appointed to investigate the causes of the inundation of the city of Rochester in March, 1865, may be found in Assembly Document No. 117 of the Session of 1866.

the more interesting and important literature of the subject, at the same time giving the detail of some observations recently obtained in this State.

THE VIEWS OF SIR GUSTAVE VON WEX.

Among the more important treatises, we may mention the writings of Sir Gustave Von Wex. Imperial and Royal Ministerial Counsellor of Austria and Chief Engineer of the improvement of the Danube river at Vienna. This author, in a splendid series of papers, has discussed the whole question of deforestation, with reference to its effects upon streams, in a more thorough manner than can be found elsewhere. While some of his conclusions have been disputed, his papers are considered as giving, on the whole, a larger body of facts bearing upon this question than can be found in any other place.*

* The following are Wex's papers:—(1) A Lecture on the Improvement of the Danube at Vienna, delivered before the Society of Austrian Engineers and Architects on March 18, 1876, by Sir Gustave v. Wex, Imperial Royal Ministerial Counsellor and Chief Director of the Improvement of the Danube. Translated by G. Weitzel, Major of Engineers, Bvt. Major-General, U. S. A. Washington; Government Printing Office. 1880. (25 pp.)

(2) A Lecture on the Progress of the Works of Completion of the New Improved Bed of the Danube at Vienna, and the Lessons taught thereby; together with a Description of the Catastrophe produced by the ice gorge of 1880.. By Sir Gustave Wex, Imperial Royal Minisisterial Counsellor and Chief Director of the Improvement of the Danube at Vienna. With five sheets of drawings. (Extracts from the Journal of the Society of Austrian Engineers, No. 3, 1880.) Translated by G. Weitzel, Major of Engineers, Bvt. Maj. Gen. U. S. Army, Washington; Government Printing Office. 1881. (93 pp.)

(3) First Treatise on the Decrease of Water in Springs, Creeks, and Rivers, contemporaneously with an increase in height of floods in Cultivated Countries, by Gustave Wex, Imperial and Royal Ministerial Counsellor and Chief Engineer of the Improvement of the Danube, at Vienna, with seven sheets of drawings. From the papers of the Society of Austrian Engineers and Architects, 1873—Nos. 2, 4, and 6. Translated by G. Weitzel, Major of Engineers, Bvt. Maj. Gen. U. S. Army, Washington; Government Printing Office. 1881. (57 pp.)

(4) Second Treatise on the Decrease of Water in Springs, Creeks and Rivers, contemporaneously with an Increase in Height of Floods in Cultivated Countries, by Sir Gustave Wex, Imperial and Royal Ministerial Counsellor and Chief Engineer of the Improvement of the Danube, at Vienna, with six sheets of drawings from the papers of the Society of the Austrian Engineers and Architects, 1879—Nos. 6-9. Translated by G. Weitzel, Major of Engineers, Bvt. Maj. Gen. U. S. A., Washington; Government Printing Office. 1880. (41 pp.)

(5) The Regulation of Rivers and Waterways, with a view to the Prevention of Floods. By Gustave Ritter Von Wex, Privy Counsellor to his Imperial Majesty the Emperor of Austria. Translated from the German by William Atkinson Bell, Assoc. M. Inst. C. E. By permission of the Council. Excerpt Minutes of the Proceedings of the Institution of Civil Engineers. Vol. lxix. Session 1881-82—Part iii. Edited by James Forrest, Secretary. London; Published by the Institution, 25 Great George Street, Westminster, S. W. 1882. (16 pp.)

In his paper On the Decrease of Water in Springs, Creeks and Rivers Contemporaneously with an Increase in Height of Floods in Cultivated Countries, Wex takes up a number of long period records of daily gauge heights of several European rivers as for instance: The Rhine, at Emmerich, from 1770 to 1835; the Rhine, at Cologne, from 1782 to 1835; the Rhine, at Germersheim, from 1840 to 1867; the Elbe, at Ungatung, from 1728 to 1869; the Oder, at Kustrin, from 1778 to 1835; the Vistula, at Kurzebrack, from 1800 to 1871; the Danube, at Vienna, from 1826 to 1871; and the Danube, at Orsova, from 1840 to 1871. A tabulation is also given of contemporaneous heights at several stations on the Danube, from 1855 to 1871. Diagrams illustrating the stated records are given with the papers.

The publication of Wex's first paper, in which he announced the broad proposition that deforestation leads to decrease in stream flow, with increase in flood heights, having attracted attention as well as excited controversy among foreign engineers, the distinguished author published a second treatise in which he answers the objections raised as well as adds considerably to the data. At the present time, while it is admitted that some of Wex's facts and conclusions may be modified, still the broad proposition that deforestation does decrease stream flow, at the same time probably adding somewhat to flood heights, may be considered as, on the whole, a sound view.

THE DATA OF STREAM FLOW VERSUS FORESTS IN THE UNITED STATES.

As regards this country, with the exception of the work of Mr. C. C. Vermeule, in New Jersey, almost nothing has been done further than the work of the Chief of Engineers, U. S. A., and of the United States Department of Agriculture, in collating the results of investigations abroad. Mr. Vermeule, however, has done

original work on this line in New Jersey which we may properly refer to further on somewhat in detail.*

As another recent paper deserving notice, we may refer to that of Thomas P. Roberts, C. E., of Pittsburg, Pennsylvania, on The Relation of Forests to Floods.†

Mr. Roberts' paper is interesting chiefly as an attempt at this late day to controvert the broad propositions of Wex's papers, by data derived chiefly from gaugings of the Ohio river at Pittsburg and Cincinnati. Tables are also given showing the movement of a flood in the Allegheny and Ohio rivers, in 1884, as taken at the same dates at Oil City, Freeport, Pittsburg, Wheeling, Marietta, Point Pleasant, Portsmouth, Cincinnati, Louisville, Evansville and Cairo. As to the flood and low water heights of the Ohio river at Pittsburg, the tables given cover the period from 1810 to 1884, while those for Cincinnati extend from 1832 to 1883. In regard to the data cited by Mr. Roberts, two criticisms may be made: (1) The periods covered are too short; (2) from what is known of the way in which such records have thus far been mostly kept in the United States, probably little dependence could be placed upon them for the determination of small differences. At any rate, his information is far too insufficient to in any degree controvert the broad propositions of Von Wex.

*See Report on Water Supply, Water Power, Flow of Streams and Attendant Phenomena. By C. C. Veremeule, Consulting Engineer. Vol. III of the Final Report of the State Geologist of New Jersey. Also an article on the Relation of Forests to the Flood of Streams, in the Annual Report of the State Geologist of New Jersey, for the year 1896. (pp. 142-66.)

The most useful publication of the U. S. Department of Agriculture bearing on influence of Forests is Bulletin No. 7 of the Forestry Division, Washington, 1893, which contains the following papers:

(1) Introduction and Summary of Conclusions. By B. E. Fernow.

(2) Review of Forest Meteorological Observations. A Study preliminary to a discussion of the Relation of Forests to Climate. By M. W. Harrington.

(3) Relation of Forests to Water Supplies. By B. E. Fernow.

(4) Notes on the Sanitary Significance of Forests. By B. E. Fernow: Appendices—(1) Determination of the True Amount of Precipitation and its Bearing on Theories of Forest Influences. By Cleveland Abbe. (2) Analysis of Rainfall with relation to Surface Conditions. By Geo. E. Curtis.

† Read before the American Forestry Congress at its Boston meeting, September, 1885.

MR. VERMEULE'S WORK IN NEW JERSEY.

Returning to the work of Mr. Vermeule, in New Jersey, we may refer to the discussion of the relation of forests to the flow of streams given in the Annual Report of the State Geologist for 1895 as being his most recent publication on this subject, and, therefore, presumably indicating his later views. Mr. Vermeule combats the idea that deforestation is in any special degree the cause of marked changes in stream flow, and cites data derived from observation of streams in New Jersey to justify this position. In regard to the data cited, the same remark may be made as has already been made about that of Mr. Roberts, namely: the periods covered are too short to give any certain determination. The data which Mr. Vermeule cites, however, are not only exceedingly interesting, but very suggestive as to the proper lines of investigation to be pursued in order to reach a final conclusion as to the real facts of the case.

WHAT THE NEW YORK STATE DATA INDICATE.

After some careful study of the question, the author's present view is that deforestation not only decreases the yield of streams but also may increase the height of floods somewhat. At present the data is not complete enough to justify final conclusions, but, so far as it can be determined, the author believes that the effect of deforestation is more marked in diminishing the actual yield of streams than it is in increasing the height of floods. As regards the latter there are certain modifying causes to which we will refer later on a little in detail.

Referring to Table No. 2, it is learned that for the storage period of the water year 1895 the total runoff at Mount Morris was only 5.63 inches on the watershed, while for the same period in 1894 the runoff was 15.73 inches on the watershed, and in 1896, 9.25 inches. For the growing period of 1895 the runoff was 0.36 inches, for 1894 1.46 inches, and for 1896 0.83 inches. For the replenishing period in 1895 0.68 inches, in 1894 2.19 inches, and for 1896 2.72 inches. The totals for each year were: 1895, 6.67 inches; 1894, 19.38 inches; 1896, 12.80 inches. We learn, therefore, that

the year 1895 was a year of exceedingly low flow. From table No. 6, of the Upper Hudson Storage report for 1895* we learn that on the Hudson river for the years 1894, 1895 and 1896 we have the following runoffs: For the storage period in 1895, 11.68 inches; 1894, 13.18 inches, and in 1896, 16.41 inches. For the growing period of 1895, 2.36 inches; 1894, 3.20 inches, and in 1896, 2.56 inches. For the replenishing period in 1895, 3.42 inches; 1894, 2.99, and in 1896, 3.94 inches. The totals for the years cited are: 1895, 17.46 inches; 1894, 19.37, and 1896, 22.88 inches. We learn, therefore, that the year 1895 was also a year of relatively low flow on the Hudson as well as on the Genesee.†

The gaugings of the Hudson river, from which these figures are taken, have been made at Mechanicville, just below the mouths of the Hoosic and Battenkill, the main tributaries of the Hudson from the east. The combined drainage area of the Hoosic river and the Battenkill is about 1,170 square miles, with the drainage areas probably not over 40 per cent. in forest. The remainder of the Hudson river area, including about 3,330 square miles, is perhaps 80 per cent. forest.

Referring to Table No. 11, we see that the mean rainfall of the Upper Genesee area for the year 1895 was, for the storage period, 13.20 inches; for the growing period, 11.13 inches, and for the replenishing period, 6.67 inches; giving a total for the year of 31 inches. In the previous year, 1894, the rainfall for the storage period is likewise seen to have been 27.71 inches, for the growing period, 7.95 inches; for the replenishing period, 12.13 inches, giving a total for the year of 47.79 inches. In 1896 the rainfall for the storage period was 17.84 inches; the growing period, 11.28 inches; for the replenishing period, 12.56 inches, giving a total for the year of 41.68 inches.

The mean temperatures for the years 1894 to 1896, inclusive are: For the storage period of 1895, 32.1°; growing period, 66°; replenishing period, 47.2°; total for the year, 44.3°. For 1894,

*Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1895, p. 107.

†For run-offs of the Hudson river 1888 to 1895 inclusive see Table No. 6 (page 107) of the Report on Upper Hudson Storage, in the Annual Report of the State Engineer and Surveyor for the fiscal year ending September 30, 1895.

storage period, 35°; growing period, 65.3°; replenishing period, 47.7°; total for the year, 45.7°. For 1896, storage period, 34.4°; growing period, 64.8°; replenishing period, 47.2°; total for the year, 45.3°.

If we refer to the Upper Hudson report for the year 1896, we learn that while the temperature for the Upper Hudson drainage area was somewhat less for the years 1894 to 1896, inclusive, than that of the Upper Genesee, still the rainfall was nearly the same. The small difference in temperature entirely fails to account for the great difference of 10.79 inches in the yield of the streams. We are forced to look to other causes for this difference. The practice of deforestation has gone on on the Genesee area until at the present time, as regards effect on water yield, the entire area is practically bare of forest. The small amount of timber still remaining is mostly second growth, and so scattered that it has very little modifying effect upon evaporation. The broad proposition is that with an elevated area such as the Upper Genesee, the cutting of the timber exposes the surface of the ground to the free sweep of the winds, thereby greatly increasing the evaporative effect, thus leading to loss of moisture from the surface of the ground and a wasting away of snow in the winter which does not take place on forested areas. In order to appreciate the significance of facts of this character thoroughly, we should understand that with the exception of perhaps from 100 to 150 square miles area, which includes the high Adirondack mountains, the general elevation of the Hudson area is not greatly different from that of the Upper Genesee. Both are mostly at an elevation of from 1,200 to 2,000 feet above tide. The center of the Genesee area is, however, about 2° of latitude south of the Hudson.

THE INDICATIONS OF MR. FITZGERALD'S EVAPORATION EXPERIMENTS.

As further bearing upon this view, we may refer to the results obtained by Mr. FitzGerald in his evaporation experiments at Boston.*

*Paper on Evaporation. By Desmond FitzGerald. Transactions of the Am. Soc. C. E. Vol. XV, Sept., 1886. (pp. 581-646.)

In determining the winter evaporation, Mr. FitzGerald found, by experimenting upon blocks of ice, that, when the blocks were so placed as to be subject to air currents, the loss was much greater than when exposed to the same temperature in still air. These results were found even in zero temperature. Mr. FitzGerald's experiments apparently indicated that the loss from ice is greater

TABLE No. 6.

Evaporation from water surface as observed at Rochester from 1891 to 1896, inclusive.

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
April	......	*2.67	*2.67	2.59	2.72	2.72	2.67
May	......	3.26	3.33	3.32	4.60	5.72	4.05
June	......	4.62	4.61	3.62	5 75	6.04	4.93
July	5 59	6 06	5.80	5.31	5.92	5.18	5.64
August	4.93	4.85	5 36	6.20	5.13	5.23	5.28
September	4 05	4.61	3.47	3.76	5.14	3.38	4.07
October	3.23	3 28	3.27	2.96	3.61	2.45	3.18
November	......	*1.51	*1.51	*1.51	1.51	*1.51	1.51
Totals	......	30.86	30.02	29.27	34.38	32.23	31.28

than from snow, although whether this would hold good on a drainage area, where the snow may become crusted and practically in the condition of ice, is uncertain. In any case the results are sufficiently definite to prove the proposition that the losses from a deforested area, subject to the full sweep of the wind, will be much greater than from a forested area. For instance, on February 24, 1896, Mr. FitzGerald found evaporation from an ice surface, with the wind at 12 miles an hour, proceeding at the rate of 0.2 inches per day. A number of experiments were made as to the evaporation from ice exposed to wind in comparison with evaporation from the same substance when protected in a covered and cold shed through and into which the wind could not penetrate, with the result of showing that the wind was an exceedingly important factor in winter evaporation, and that, therefore, whenever we do anything which tends to give the wind freer access to the snow cover-

* Not in record, mean used.

ing of a drainage area we have done that which will lead to a large loss of water from the area. It is facts of this character which emphasize the injury done to streams by deforestation.

THE ROCHESTER EVAPORATION DATA.

We may now refer to further applications of evaporation data to the solution of the specific problem in hand. In Table No. 6 we have the evaporation from a water surface, as observed at Rochester, for the months indicated from April to November, inclusive, during the years 1891 to 1896. The data of this table have obtained by observing the changes in elevation of the water surface in a tub floating on the surface of the Mt. Hope reservoir of the water-works at that city, and may be taken as representing the approximate evaporation from a free water surface in Western New York.

In Table No. 7 we have the evaporation from a water surface in an exposed tub on land observed at Rochester for the same months and period covered by Table No. 6.

TABLE No. 7.

Evaporation from exposed tub on land, as observed at Rochester, from 1891 *to* 1896, *inclusive.*

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
April	......	*4.59	*4.59	4.39	4.91	4.46	4.59
May	......	4.93	6.02	5 52	8.84	7.88	6.64
June	......	7.21	8.33	7.67	9.53	8.03	8.15
July	6.46	8.58	8.65	8.86	8.81	7.10	8 08
August	5.70	6.85	7.35	7.85	7.19	6.93	6.98
September	5 04	6.08	4.83	5.19	6.91	4.30	5.39
October	3.55	3.46	4.38	3.32	4.08	2.51	3.55
November	......	*1.49	*1.49	*1.49	1.49	*1.49	1.49
Total	......	43.19	45.64	44.29	51.76	42.70	44.87

Comparing the footings and means of the two tables, it is seen that the totals for the months from April to November, inclusive, are much higher in Table No. 7 than in Table No. 6, thus indicating saliently the higher evaporation which takes place from the exposed tub on land. Owing to the difficulty of making winter ob-

* Not in record, mean of the indicated month used.

servations, no determinations of evaporation have yet been made at Rochester for the months from December to March, inclusive, but we may obtain an approximate idea of the probable quantity for those months by comparison with Mr. FitzGerald's observations at Boston, which include the most extended evaporation observations thus far made in the United States. As pointed out in the Annual Report of the Chief Engineer of the Rochester Water-Works for the period from April 1, 1894, to January 1, 1896,* for the six months from May 1, to October 31, the total evaporation is 26.78 inches. The total mean evaporation for the same months at Boston is 29.46 inches; the distribution by months being as follows:

	Boston.	Rochester.
May	4.46	3.63
June	5.94	4.65
July	5.98	5.74
August	5.50	5.29
September	4.12	4.20
October	3.46	3.27
	29.46	26.78

Dividing the Rochester footings of 26.78 by 29.46 we obtain the ratio 0.909. Applying this to the Boston results from November to April, inclusive, we have the following:

	Boston.	Rochester.
November	2.25	2.05
December	1.51	1.37
January	0.96	0.87
February	1.05	0.96
March	1.70	1.55
April	2.97	2.70
	10.44	9.50

*Report of E. Kuichling, Chief Engineer of the Rochester Water-Works, as given in the Annual Report of the Excutive Board of the city of Rochester, for the years from April 1, 1894, to Jan. 1, 1896.

In computing the losses by evaporation from the water surfaces of the proposed reservoir, as given further on, we will use the data from the Rochester observations so far as it applies, as per Table No. 6. For the months not covered by this table we will use the preceding coefficients derived from the Boston data by comparison.*

A comparison of Tables Nos. 6 and 7 will assist in determining why the stream flow of the year 1895 was so small. For instance, from Table No. 6 we learn that the evaporation from the water surface of the Mt. Hope reservoir of the Rochester Water-Works was, for the months of April to November, 1895, inclusive, considerably beyond the average. We have, as the sum of the means for the period April to November, for the years 1891 to 1896, inclusive, 31.28 inches, while for the same months in 1895 the total evaporation from the reservoir surface was 34.38 inches, an increase for that year of 3.1 inches, equal to nearly 10 per cent. In the same way it appears that in 1896 evaporation from the reservoir surface was 0.95 inches greater than the average.

If we refer to Table No. 7, showing evaporation from the surface of water freely exposed in a tub on land, we find the excess above the mean in 1895 was still more marked. In this case we have the sum of the means for the months from April to November, inclusive, 44.87 inches, while for the year 1895 the sum is for the given months 51.76 inches, an excess above the mean of 6.89 inches, or not far from 15 per cent.

From the Rochester meteorological records it is learned that the mean temperature of the air for the period in 1895, from April to November, inclusive, was 58.1° F., which is 1.4° above the mean for twenty-five years. Again, the relative humidity for the same period in 1895 was 67.64 per cent., which is 2.75 per cent. below the mean for twenty-five years. It is clear, therefore, that during the warm months of the year 1895 the conditions in Western New York were not only favorable for excessive evaporation, but that the indications of Tables Nos. 6 and 7 are in accord with the general meteorological record.†

*Table No. 6, was prepared before the data for the year 1896, was received and hence the results for that year are not included in the mean of 26.78 inches for the six months from May to October inclusive.

†From the Rochester meteorological records as kept by the United States Weather Bureau.

GENERAL EVAPORATION DATA.

Referring to Tables Nos. 2 and 11 we derive the following data as to the runoff of the Genesee river and the rainfall of the drainage area, the data here given being all in inches on the watershed:

	Rainfall.	Runoff.	Evaporation.
1894	47.79	19.38	28.41
1895	31.00	6.67	24.33
1896	41.68	12.80	28.88

Comparing these figures with those of Table No. 7 we learn that in 1895 the loss of water from the Genesee watershed was not as great as in the years 1894 and 1896, an apparent reversal of the indication in Table No. 7. We may consider, however, that aside from variations due to meteorological conditions the demands of evaporation, especially as regards vegetation, are substantially the same from year to year — at any rate this must be true so long as cultivation, forestation, etc., remain substantially in the same state. The variations in total evaporation, loss of water, etc., from year to year are those due to fluctuations in meteorological conditions solely. The year 1895 was, however, a year of relatively low rainfall, the total for the year being 16.79 inches less than the total for the preceding year, 1894. Further, referring to Table No. 11, we learn the rainfall of the months of April and May, 1895, was low, being 2.1 inches in April and 2.43 inches in May. We also learn that the total rainfall of the storage period for that year was only 13.2 inches. Further, the temperature of May, 1895, was 2.7° F. above the mean, which had the effect of starting vegetation luxuriantly early in the month. The rainfall of the growing period was 11.13 inches, which, however, all went to support vegetation, the runoff for the growing period, amounting to only 0.36 inches was supported entirely by the stored ground water.

From Table 15 it is also learned that the temperature of the storage period of 1895 was 1.8° F. lower than the mean for the period. Had it been as high as in 1884 and 1896 we may conclude that the runoff for the storage period of 1895 would have been

even less than the actually observed 5.63 inches. The conclusion may be drawn, therefore, that there are two main reasons why the total evaporation for the year 1895 is less than that for the years 1894 and 1896: (1) The demands of vegetation were not fully met that year, as evidenced by the drying up of the forests in July and August, and this, too, with a relatively full rainfall for the growing period; (2) the evaporation of the storage period was greater than in the years 1894 and 1896.

Again, referring to the foregoing tabulation we may draw the tentative conclusion that, in years of plentiful rainfall, the ordinary demands of evaporation on the Upper Genesee watershed are something over 28 inches; but in the year 1895, by reason of inadequate rain supply, the evaporation fell to 24.33 inches. The reason, therefore, why the total evaporation from the drainage area is less than the normal in years of deficient rainfall is because of lack of water to fully supply all the demands. In the year 1895 the shortage on the Genesee area apparently amounted to about 4 inches on the watershed.

We may now refer to the rainfall, runoff and evaporation of the Upper Hudson area for the years 1894-1896. By way of comparison we have the following:

Year.	Rainfall.	Runoff.	Evaporation.
1894	41.37	19.37	22.00
1895	36.67	17.46	19.21
1896	45.21	22.88	22.33

Comparing these figures, it appears that the evaporation for the years 1894 and 1896, with the rainfall about normal, reached 22 inches; but in 1895, with a somewhat deficient rainfall, the evaporation fell to 19.21 inches. We may conclude, tentatively, therefore, that about 22 inches evaporation may be expected on the Upper Hudson in years when the rainfall is sufficient to fairly satisfy the several demands.

As a further deduction it may be concluded that the difference in evaporation between the Upper Hudson area and the Upper

Genesee is about 6 inches, although it should not be overlooked that this conclusion is tentative purely, as the data are not yet extended enough to enable one to fully decide. All that we can do at present is to point out what the data at hand apparently indicate.

We may now consider another class of data applying to the problem in hand. Referring to the report on Genesee Storage of date April 1, 1894,* we find on page 374 of that report a statement of the quantity of water taken up by various crops and two classes of forest trees. These data were obtained by E. Risler from carefully underdrained areas on which the amount of water applied from day to day by irrigation as well as the rainfall and the runoff from the drains were fully known. These data are extremely valuable and pertinent to the present discussion, although, in their use, it should not be overlooked that there may have been some loss of water by sinking into the ground, which was not taken cognizance of by the drains. In any case, however, the loss would have been relatively the same for the various meteorological conditions, so that the results, while not absolutely true, would still be comparable. Referring to Risler's results, it appears that ordinary farm crops, such as meadow grass, oats, Indian corn, clover, wheat and rye require considerably larger quantities of water than either oak trees or fir trees. Without again discussing these data in detail, it may be pointed out that ordinary farm crops take up from 12 to 15 inches of water over the whole area of crop during the growing period, while forests take up from 4 to 5 inches, and uncultivated, cleared areas from 7 to 8 inches. On this basis we would have a difference in the amount of water evaporated from a forested area, in comparison with a deforested, cultivated one, of perhaps 5 to 6 inches, results which are fairly comparable with those already obtained from the Upper Genesee and Upper Hudson drainage areas, upon the broad basis of total evaporation as deduced from the observed rainfall and runoff.

*Final Report on the Genesee River Storage project, in Appendix E of the Annual Report of the State Engineer and Surveyor for the fiscal year ending Sept. 30, 1894.

FOREST METEOROLOGY ABROAD.

As another class of data applicable to the problem in hand, we may refer to the observations on forest meteorology which have been made in recent years in various European countries. The first observations of this character were made by M. A. C. Becquerel, who began a series of such in 1858. Becquerel's observations have been continued either at Paris or in the vicinity of that city from 1858 to the present time.

In 1868 Dr. E. Ebermayer began, with the aid of the government of Bavaria, his well-known series of observations. They relate exclusively to the problem of the climate of the interior of forests. The conclusions arrived at by Ebermayer's early observations have been confirmed by the later.

TABLE No. 7 A.

Evaporation in the forest in per cent. of evaporation in the open.

MONTH.	DR. EBERMAYER'S RESULTS.						GERMAN OBSERVATIONS.		
	WATER SURFACE.		BARE SOIL.		Soil under forest litter and within forest.	Rainfall.	WATER SURFACE.		Rainfall.
	Open.	Woods.	Open.	Woods.			Open.	Woods.	
April	1	0.45	1 15	0.64	0.27	1 75	1	0 51	1.37
May	1	0 43	0.91	0.37	0 16	0.68	1	0.47	1.35
June	1	0.36	1 07	0.38	0.14	1 46	1	0.41	1.91
July	1	0.35	0.89	0.34	0.12	1.02	1	0.38	2.33
August	1	0 34	0.87	0.36	0.11	1.00	1	0 36	1 98
September	1	0.33	0.92	0.39	0.11	0.59	1	0.35	2.54
October	1	0.41	1 26	0 44	0.18	3.45	1	0.37	8.49
May-September	1	0.36	0.93	0.35	0.13	0 95	1	0.39	2.02

In 1875 the German Meteorological Forestry Service was established with stations selected to represent every variety of position possible as to distance from the coast, topography, kind of forest, etc. There are seventeen stations; ten in Prussia, three on the Imperial lands, and one each in Wurtemburg, Brunswick, Thuringia and Hanover. The elevations of the stations above tide vary from 10 feet at Schoo to 3,064 feet at Melkerei.

Stations for the study of meteorology of forests have also been established in Sweden, Austria and in Russia.

The results obtained are too elaborate to be gone into in detail here. They show in a general way that the evaporation from water surfaces, or from the bare soil in the woods, is only about one-third what it is in the open. This fact is strongly brought out by Table No. 7A. Certainly if any such difference in evaporation between the open and the wood exists as shown by these tabulations, the great difference in runoff between streams from forested areas as compared with deforested is at once explained. It is claimed, however, by those opposing the view that forests add to the runoff of streams, that data of this character has no significance, because we have no way of knowing what is going on in the way of evaporation from the trunks of trees and from the leaves themselves. It appears to the present writer, however, that this argument is fully met by Risler's results, which show a less demand for water in the case of forest trees than for growing crops. The forest meteorological observations show generally that the rainfall in forests is slightly greater than in the open, and, so far as tentative conclusions can be drawn in the present state of information, it may be stated that the excess of rainfall in large forest areas over what would exist there if the area were deforested probably is amply sufficient to compensate for the unmeasured evaporation from the trunks and leaves of the trees. The matter is, therefore, reduced to a comparison of the actually measured rainfall of the forest with the actually observed evaporation, and, while it is true that the absolute quantity of rainfall is not taken into account because of the difficulty of gaging it all with the rain-gage in the forest, the excess over what would exist there if it were open, probably compensates. The foreign observations show that the rainfall of extensive forested areas is somewhat greater than that of extensive open areas, although for reasons indicated in the foregoing only about 70 per cent. as much reaches the rain-gage in the woods as in the open, the balance being caught in the leaves or branches, and probably mostly passing to the ground by running down the trunks.

In regard to the results of Table No. 7A it may be stated that the German observations include the means for ten years.

One striking feature exhibited by the data of Table No. 7A is the

effect of the presence of forest litter on the evaporation from soil within forests. Referring to the column giving the evaporation from soil under forest litter within the forest, we find as the mean of the months from April to October, inclusive, that the evaporation under such conditions is only 13 per cent. of what it is from a water surface in the open. The significance of facts of this character is strongly brought out when we compare the results obtained at Rochester, as given by Tables Nos. 6 and 7, from which it appears that the evaporation from the exposed tub was greater than that from an extended water surface.

The literature of Forest Meteorology has grown quite extensive, but lack of space precludes more extended reference here.*

---

*In addition to that already cited the following literature of Forest Meteorology may be consulted by those interested in the subject:

(1) Klimatologie. By Dr. J. R. Lorentz.
(2) Meteorologie and Klimatologie. By Dr. Hornberger.
(3) Klimatologie. By Dr. Jul Hann.
(4) Jahresbericht d Ergebnisse der Forstl. Meteorol. Versuchsanst. By Dr. A. Muttrich (fr. 1884 to date).
(5) Resultate Forstl. Meteorolog. Beob., Vol. I and II, 1885-87. By Dr. J. Lorentz-Liburnau.
(6) Simmons Brit. Rainfall. 4 Vols.
(7) Climatol, of U. S., Blodget.
(8) Beschaffenheit d Waldluft. Dr. E. Ebermayer.
(9) Physakalische Einwirkungen d Waldes auf Luft und Boden. By E. Ebermayer.
(10) Earth as Modified by Man. Marsh.
(11) Soyka Grund-Wasser, etc.
(12) Hough's Report on Forestry. Vol. I, p. 262. Etc.
(13) Hand-Buch d. Forstwissenschaft. Lorey & Lehr.
(14) Ztschr. f. F. und Jagdwesen, 1891, p. 182. A good article with some biography, giving Malthieus' results and also Fautrat's.
(15) ibid, 1893, p. 28. By Dr. Schubert. Temp. Im Feld und Wald.
ibid, ditto, p. 441. Temp. and Moisture in Wood and Forest.
(16) ibid, 1892, p. 27. Dr. Muttrich. Precipitation and Forest.
(17) ibid, 1888. Dr. Grossmann. "Die Heutige Gewitter-forchung und Ihre Ergebnisse." p. 289.
(18) ibid, 1888, p. 728. Soil Temp. in and out of Forest. Schubert.
(19) ibid, p. 19, same as Eberswalde.
(20) ibid, p. 34. Rain and Woods. Refer to Studnicka's work for Bohemia.
(21) ibid, 1892, p. 358. Dankelman. "Wald und Hochswasser on d. Wupper."
(22) Mittheilungen d Schweizerischen Centralanstalt fur d. Forstliche Versuchswesen. By Dr. Buhler. 325 pages. Vol. IV.
(23) Bedeutung und Wichtigeit d. Waldes (800 p. Book). By Loeffelholz-Colberg. An excellent little book; contains full list of authors, giving essence of opinion and experience. Leipzig. 1872. Published by H. Schmidt.
(24) Bibliography. See also Jahresbericht, Mutttrich, at end of each volume
(25) Comptes Rendus. Vol. 83. 1876. p. 514. Fautrat's Article on effect of Forests on Rain; Effect on Temp. p. 752.
(26) ibid, years 1875-76-77, are articles of Becquerel on Soil Temp. made at Paris on naked and covered Soils.
(27) ibid, Vol. 85. Fautrat. Humidity, Influence on, by Forest. p. 340.
(28) ibid, Vol. 85, Fautrat. Forest and Climate. p. 1,116.
(29) ibid, Vol. 89 (1879) p. 1,051. Fautrat. Influence of Forest on current Rainclouds.

The foregoing literature of forest meteorology may be found in the library of the U. S. Department of Agriculture.

HOW DEFORESTATION REALLY AFFECTS FLOODS.

We have already expressed the opinion on page 648 that probably the effect of deforestation is somewhat more marked in diminishing the actual yield of streams than it is in increasing the height of floods. The reasons for this have been partially indicated in the preceding discussion as to the more considerable wasting away of snow and moisture generally from deforested areas than from protected ones. As to the further bearing of this view on flood flows, it may be pointed out that, taking Mr. FitzGerald's actual experience with ice evaporation as a basis, the wasting away of the snow on a deforested area would be, for the entire winter, very considerable, hence other things being equal, the amount of snow to be suddenly melted in case of extreme warm weather in early spring would be less. On the other hand, with the snowfall protected by a forest covering, the wasting away at a time of high spring temperature is slower than on an exposed area subject to the same temperature. The forest meteorological observations

TABLE No. 8.

Precipitation at Angelica from 1889 *to* 1896, *inclusive.*

(In inches.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	*2.97	3.29	2 77	3.84	1.13	3.58	2.23	4.02	2.97
January	3.10	3.47	1.86	3.27	2.44	4.45	3.35	2.34	3.04
February	1.26	2.33	1.63	3.06	4.87	2.81	1.38	4.16	2.68
March	1.67	2.63	†2.45	3.55	2.87	1.78	2.86	4.21	2.75
April	3.81	3.59	2.46	1.57	4.37	7.77	2.72	1.58	3.48
May	5.12	7.38	1.25	7 31	5.65	8.82	2.01	1.99	4.94
Total	17.93	22.69	12 42	22.60	20.83	29.16	14.55	18.80	19.81
June	7.43	4.52	3.48	5.14	2.35	2.02	4.10	3.26	4.04
July	5.00	2.94	†6.26	2.55	1.79	4.14	2.40	5.66	3.84
August	2.60	6.72	5.39	3.67	5.22	2.26	3.96	2.63	4.05
Total	15.03	14.18	15.13	11.36	9.36	8.42	10.46	11.55	11.93
September	2.34	8.72	1.37	2.68	2.67	7.14	1.92	4.96	3.98
October	3.33	4.72	2.61	2 51	2.49	3.37	1.32	3.18	2.94
November	4.27	2.28	2.33	3.60	2.12	1.70	3.46	2.08	2.73
Total	9.94	15.72	6.31	8.79	7.:28	12.21	6.70	10.22	9.65
Yearly total	42.90	52.59	33.86	42 75	37.47	49.79	31.71	40.07	41.39

* Missing from record — the mean of Alfred and Humphrey has been used. † Missing from record — the mean of all the Decembers given has been used.

show that this conclusion must be essentially true. We have, then, a balance, of conditions in which the effect of the forest in increasing the tendency to extreme flood at the time of the spring breakup, by the storage of large quantities of snow, is modified by the greater loss from evaporation taking place on a deforested area during the entire winter season. Hence, as regards floods caused by the sudden melting of winter snows, there is an essential balance, the net result being, in the case of deforested areas, a shortening of the time of extreme spring runoff, with, by reason of the gradual wasting away during the winter, ordinarily no special increase in height of flood.

As regards floods due to heavy rains, either in the spring or fall, and which occur without reference to the spring breakup, a similar line of reasoning applies. Exposure of the ground on a deforested area leads to a more rapid evaporation from the surface, with quicker exhaustion of the surface moisture. Hence, usually the ground in the open is in condition, at the beginning of an extreme rainfall, to absorb considerably more water before large quantities begin to run off than it would be if covered with forest. In this way a balance of spring, summer and fall flood conditions is likewise attained on the deforested area the same as during the winter. The conclusion appears to be easily drawn, therefore, (1) that while deforestation does actually decrease the net annual runoff of streams, still (2) it does not *per se* necessarily materially increase the height of floods. As meeting, therefore, the objections of some writers, it remains to point out that the mere fact of non-increase of floods is absolutely no proof that there is not a material decrease in total runoff from deforested areas.

In considering the foregoing views we must not overlook that thorough drainage of an area may so decrease the time of maximum runoff as to increase the flood heights. This is especially true in any region where large, open, drainage ditches have been cut. As an example of a stream the regimen of which has been entirely changed by open drainage, we may refer to Flint creek in Ontario and Yates counties in this State. The headwaters of this stream

are in Yates county and flow through what was originally an extensive cedar swamp about ten miles long and from one-half to three-quarters of a mile in width. During the author's boyhood there were a series of flouring mills on this stream from the foot of the swamp down, all of which had, generally speaking, ample power to run by water during the summer season. About thirty years ago, however, the channel of the stream through the swamp was cleared out and straightened by joint action of the abutting owners, the swamp itself cleared, drainage ditches cut and the land mostly brought under cultivation. The result is Flint creek has become worthless as a mill stream. The mills have either added steam engines to their power plants or been allowed to fall into decay. Nearly every year there are heavy floods for a few days in the spring, followed by several months of extreme low water. Parties who have observed the flow of the stream during the period claim that even the winter flows are much less equable than formerly. There is more tendency now to extremely low flows at that season.

As to the effect of ordinary land underdrainage, opinions vary. One effect of such drainage is to increase the porosity of the soil, whereby more water percolates to the underdrains and is discharged through them, thus decreasing the surface runoff, and in this way possibly increasing the length of time of any given runoff. W. H. Wheeler, Mem. Inst. C. E., in an able paper on the prevention of floods, holds the view that underdraining, by reason of increasing the porosity of the soil, must necessarily increase the rapidity of the runoff.* As to the increased porosity of the soil, Mr. Wheeler says it has two offices, (1) it allows water to drain away more rapidly in wet weather — by this process swamp areas are brought under cultivation — and (2) it retains more moisture in the pores in dry weather.

In a general way we may say, therefore, that thorough draining of extensive areas tends to increase the flood heights of the

*On River Conservancy and the Cause and Prevention of Floods. By W. H. Wheeler, Mem. Inst. C. E. Jour. of the Royal Agricultural Society of England. (See ser.) Vol. XIX, Pt. II, No. XXXVIII (1888), pp. 388-411.

streams issuing therefrom, though the modifying effect of the increased evaporative effect on deforested areas may produce such a balance of conditions as to produce the net result of no greater floods than when in the natural forested condition. We must conclude, therefore, that the problem is complex and only solvable when we take into account all the conditions.*

Concluding the discussion of the effect of forestation on streamflow we may draw the following tentative conclusions:

(1) The available data indicate a very marked influence of forests on stream flow.

(2) The data for a full discussion of the relation of forests to stream flow are necessarily of wide range, and must include not only a consideration of the runoff of streams in comparison with the rainfall of drainage areas, but also the data derived from forest meteorological observations as well.

(3) So far as present observation goes, the evaporation of the Genesee watershed in a year of ordinary rainfall is apparently about 28 inches. In the year 1895, with a deficient rainfall, the evaporation was only 24.38 inches.

(4) In years of ordinarily full rainfall, evaporation from the Upper Hudson watershed may be placed at about 22 inches. In 1895, with the rainfall somewhat deficient, evaporation was 19.21 inches.

(5) The difference of about 6 to 6.5 inches, which is found to exist between the ordinary evaporation of the Upper Genesee area and that of the Hudson, may be taken as representing for the present the difference between forested and deforested areas in the State of New York.

As already stated, these conclusions are tentative and subject to modification, the data not being sufficiently extended for final conclusions.

THE SUMMER FLOW OF THE GENESEE RIVER IN 1846.

Tables Nos. 1, 2 and 3 show conclusively that the Genesee river, in its recent condition of a nearly completely deforested drainage area, is not a good mill stream. The great variations in runoff

*For more extended discussion of this phase of the subject with detailed references to the literature see the report on the survey of the Upper Hudson River Valley.

from month to month which are there exhibited, are conclusive on this point. It appears that the runoff of the stream is exceedingly slight in the summer as well as frequently so during the fall months, September-November, inclusive. That the summer runoff of the Genesee has not always been as low as at present may be shown by reference to the gagings made in 1846 and 1856 by engineers in the employ of the State, as well as by engineers employed by the mill owners of Rochester.* According to gagings

TABLE No. 9.

Precipitation at Alfred Centre from June, 1889, *to November,* 1896, *inclusive.*

(In inches.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	......	2.55	2.72	3.60	0.62	3.13	3.02	4.03	2.81
January	......	3.30	2.22	4.06	4.45	3.02	3.39	2.51	3.28
February	......	2.31	4.27	2.76	4.15	2.81	0.95	3.28	2 93
March	......	3.01	2.54	3.18	3.34	1.35	1.30	4.83	2.72
April	......	3.56	2.21	0.55	2.23	8.09	1.61	1.69	2.85
May	......	6.95	0.60	5.80	5 89	7.91	2.90	2.62	4 67
Total	......	21.68	14.56	19.95	20.68	26.31	13.17	18.46	19.26
June	5.66	3.42	2.46	5.48	1.93	2 14	4.69	4.07	3.73
July	4.47	1.63	5.30	2.14	3.02	2.96	2.60	4.49	3.33
August	1.85	6.17	5.01	3.72	4.95	0.56	4.27	1.11	3.45
Total	11.98	11.22	12.77	11.34	9.90	5.66	11.56	9 67	10.51
September	1 82	9.47	1.22	2.04	4 90	6.88	0.95	5.04	3.90
October	2.44	4.79	2.61	1 44	3.30	3.64	1.13	5.02	2.76
November	3.48	1 60	1.73	4.31	2 98	1.37	3.34	2.15	2.69
Total	7.74	15.86	5.56	7.79	11.18	11.89	5.42	12.21	9 35
Yearly total	......	48.76	32.89	39.08	41.56	43 86	30 15	40.34	39.52

made by Daniel Marsh, the low water flow of the Genesee river in July and August, 1846, was 412 cubic feet per second. Mr. Marsh gives this figure as the average of nine gagings made at various times in the months in question.

If we examine the meteorological records of Western New York for the years 1844-46, we find that the period covered was one of

*See (1) Assembly Document No. 63, 1854, a Communication from the Canal Appraisers in relation to the claims of Jacob Graves and others, millowners at Rochester; (2) Senate Document No. 103, 1856. Awards and Testimony in the claims of the Rochester Millowners for the diversion of the waters of the Genesee river for supply of the Erie and Genesee Valley Canals. Heard by the Canal Appraisers, under Chapter 462, Laws of 1855.

low rainfall. For instance, at Rochester, the rainfall for the storage period of the year 1846 (from December, 1845, to May, 1846, inclusive), was only 11.57 inches; the rainfall for the growing period was 11.3 inches, and for the replenishing period, 13.16 inches; the total for the year 1846 being 36.03 inches. For 1845 the total was 34.66 inches. For 1844 we have for the storage period, 10.52 inches; growing period, 8.23 inches; replenishing period, 7.68 inches; total for the year, 26.43 inches. Table No. 22 gives full information on this point. Again, examining the records at Middlebury academy, Wyoming county, in the drainage area of Oatka creek, as given in Table No. 21, we find that the record for 1845 was, for the storage period, 12.59 inches; growing period, 4.82 inches; replenishing period, 8.6 inches; total for the year, 26.01 inches. The record for the year 1846 at Middlebury is not given.* It is clear, therefore, so far as we have any definite meteorological record, that the gagings made by Mr. Marsh in 1846 were at a time of very low water.

THE SUMMER FLOW OF THE GENESEE RIVER IN 1895.

The gagings made in 1895, as indicated by Tables Nos. 1, 2, 3 and 4, show that in the month of July of that year the flow at Rochester may have been as low as 232 cubic feet per second for the entire month, and in September as low as 221 cubic feet per second for the entire month. These results, it will be noticed, are derived from the actual gagings at Mount Morris by comparison of drainage areas. Taking the approximate gagings made at Rochester at the Johnson and Seymour dam for the same year, and we have 220 cubic feet per second as the mean of the month of October. Further gagings made at the raceway of the Genesee Paper Company, during the summer of 1895, indicate that on several occasions the flow was somewhat less than 200 cubic feet per second. If we add to these various figures the amounts actually taken for the use of the canal during that season, we reach a total flow at

*For reference to meteorology for years 1844-46, etc., see Results of Series of Observations made by the Regents of the University, at sundry academies in the State of New York from 1826 to 1850 inclusive. As compiled from the original returns and the Annual Reports of the Regents of the University by Franklin B. Hough.

TABLE No. 10.

Precipitation at Friendship and Humphrey, from 1889 *to* 1896, *inclusive.*

(In inches.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	†2.92	*4.98	*1.91	*4.38	*1.95	3.51	2.15	3.35	3.14
January	4 25	*5.02	*1.82	*3.39	1.16	4.26	3.03	2.03	3.12
February	2.45	*3.91	*4.55	*3.45	4.96	3.17	1.34	3.23	3.38
March	4.85	*3.34	*2.36	*3.45	2.33	1.78	1.01	3.45	2.82
April	4.53	*4.95	*2.17	*1.48	4.34	5.81	1.96	1.58	3.35
May	6.60	*9.11	*1.45	*7.46	5.70	9.19	2.39	3.09	5.63
Total	25.60	31.31	14.26	23.61	20.44	27 67	11.88	16.73	21.44
June	4.92	*3.76	*5.95	*6.34	2.04	3.37	4.91	3 22	4.31
July	4.30	*3.43	*7.22	*4.88	2.01	3 99	2.72	4.54	4.14
August	2 83	*5.11	*6.63	*4.45	5.33	2.41	3.74	1.83	4.04
Total	12.05	12.30	19.80	15.67	9.38	9.77	11.37	9.59	12 49
September	*3.12	*9.00	*2.04	*2.55	3.65	6.89	3 02	5.65	4.49
October	*2.40	*5.94	*2.42	*3.65	3 07	3 50	1.44	4 03	3.31
November	*4.51	*3.81	*4.09	*4.02	2.12	1.92	3.44	2.29	3 27
Total	10.03	18.75	8.55	10 22	8.84	12.31	7.90	11.97	11 07
Yearly total	47.68	62.36	42.61	49.50	38.66	49.75	31.15	38.29	45.00

Rochester of about 250 cubic feet per second, which is 162 cubic feet per second less than the low water flow of 1846, as determined by Mr. Marsh. So far as we can determine, this quantity represents the approximate reduction in the minimum flow due to deforestation. In 1846 the Upper Genesee area was still very largely in forest — probably for the entire area above Rochester the virgin forest was from 65 to 70 per cent. of the whole. We have, therefore, apparently a marked case where the deforestation of a large area has materially reduced the minimum runoff.

THE STATE SHOULD APPLY A REMEDY.

That the Genesee river, in its present state of deforestation is not an especially good mill stream must be considered as established by the preceding discussion. Moreover, when we consider that the change in the water yielding qualities of the stream is due to the act of citizens of the State who, as owners of timber

* Humphrey record; Friendship missing for these months.

† Missing, mean of Alfred and Angelica used.

lands on its headwaters, have caused the deforestation as a mere matter of commercial profit to themselves, we find a very strong reason why the State, as Sovereign, should undo the work of its citizens — a work which, while giving a temporary commercial advantage to themselves, still, so long as the drainage area remains deforested, has permanently injured every riparian owner on the the stream. A remedy may be applied by the State in two ways, either by the slow process of reforestation under the fostering care of rational forest laws, or by the quick process of river regulation by the construction of storage reservoirs. As to which of these two methods to apply, there can be no question, when we consider that the full effect of the first could only be obtained in from fifty to one hundred years; while the full effect of the second may be realized in from two to four years. When we take into account the element of time, the latter is at once found to be commercially far preferable.

WHAT THE PORTAGE PROJECT INCLUDES.

The proposed Portage reservoir presents many features markedly different from the proposed reservoir in the Mount Morris canyon. By way of illustrating some of these differences we may refer to the physical and other features involved at Portage a little in detail.

At the distance of 3000 feet up the river from the Erie Railway bridge at Portage we have the extreme head of the Genesee canyon, while just below the Erie bridge we find the Upper Portage fall. The distance from the upper fall to the mouth of the canyon at Mount Morris is about 20 miles as measured along the river channel. The elevation of the river bed just above the upper fall is 1082 feet above tide water. The elevation of the crest of the Mount Morris Hydraulic Power Company's dam, just below the mouth of the canyon, is 582 feet above tide water, which elevation, we may remark, would be taken as the mean river elevation above which to raise the water by the proposed dam at Mount Morris. The preceding figures show a total fall in the river from just above

TABLE No. 11.

Mean precipitation of the upper Genesee drainage area for the water years 1889 *to* 1896, *inclusive.*

[As derived by combining Tables Nos. 8, 9 and 10.]

(In inches.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	2.94	3.60	2.46	3.94	1.23	3.39	2.47	3 80	2.98
January	3.67	3.98	1.96	3.57	2.68	3.91	3.26	2.29	3.16
February	1.85	2.85	3.48	3.09	4.49	2.93	1.22	3.56	2.93
March	3.26	2.99	2.45	3.39	2.85	1.62	1.72	4.00	2 78
April	4.17	4.03	2.28	1.20	3.65	7.22	2.10	1.62	3.28
May	5.86	7.81	1.10	6.86	5.75	8.64	2.43	2.57	5.13
Total	21.75	25.21	13.73	22.05	20.65	27.71	13.20	17.84	20.26
June	6.00	3.90	3.96	5.65	2.11	2.51	4.57	3.52	4.03
July	4.59	2.66	6.26	3.19	2.27	3.70	2.57	4.90	3.77
August	2.43	6.00	5.68	3.95	5.17	1.74	3.99	1.86	3.85
Total	13 02	12.56	15.90	12.79	9.55	7.95	11.13	10 28	11.65
September	2.42	9.06	1.54	2.42	3.74	6.97	1.96	5.22	4.17
October	2.72	5 15	2.55	2.53	2.95	3.50	1.30	4.08	3.10
November	4.08	2.56	2.72	3.98	2 41	1.66	3.41	3.26	3.01
Total	9.22	16.77	6.81	8.93	9.10	12.13	6.67	12.56	10.28
Yearly total	43.99	54.54	36.44	43.77	39.30	47.79	31.00	40.68	42.19

the brink of the upper fall at Portage to Mount Morris of 1082—582 = 500 feet, every foot of which is available for power purposes with the dam located at Portage. On the contrary, with the dam located at Mount Morris, not a single foot of this 500 feet would be available for power purposes. We shall see further on that this additional 500 feet head puts a materially different phase on the commercial side of the Genesee storage project.

CONDITIONS AT THE PORTAGE SITE.

At a point 1400 feet above the Erie Railway bridge the Portage gorge presents extremely favorable conditions for the erection of a high dam. Solid rock exists immediately in the bed of the river, with only a couple of feet of water flowing over it, and also extends high up on the bluffs at either side. The channel is much narrower than the most favorable location surveyed in the Mount Morris canyon — so much so that the actual quantity of masonry required to construct a dam 118 feet in height is less than one-half

the quantity required for a dam 130 feet in height as proposed at Mount Morris. It is proper to remark that a portion of the decrease is due to much less depth of foundation required, although a considerable part of it is also due to less length of dam. The Portage location is, therefore, far superior to the Mount Morris in every particular. As a matter of cost, the dam alone, without reference to right of way, etc., is estimated at only $1,000,000. A dam at this location, 118 feet in height, will store 15,000,000,000 cubic feet, as against a mean storage at Mount Morris, as shown on page 638, of 7,370,000,000 cubic feet.

NEW FEATURES OF THE PORTAGE PROJECT.

The Portage project, moreover, includes a number of features which do not appear in the Mount Morris project. A short distance above the proposed Portage site the Upper Genesee valley broadens out until we have a width in places of from one to two miles. The general width of the valley for several miles of its extent may be

TABLE No. 12.

Mean monthly temperatures at Angelica from 1889 *to* 1896, *inclusive.*

(F°.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	35.4	34.3	21.2	33.1	22 6	27.3	28.1	30.1	29.0
January	27.8	31.9	25.2	19.0	13.9	28.4	18 3	22.2	23.3
February	17 0	31 4	27.7	26.1	21.2	19.5	13.2	23.2	22.4
March	32.4	26.6	29.4	23.7	29.7	38.0	26 5	23 3	28.7
April	43 3	42.7	45.0	41.1	42.1	41.8	43.1	48.2	43.5
May	56.6	53.2	51.4	53.0	52.7	54.4	56.8	60.6	54.8
Mean	35.4	36.7	33.3	32.7	30.4	34.9	31.0	34.6	33.6
June	62.2	65.5	64.2	66.5	65.5	64.4	65.8	62 8	64.6
July	67.4	65.9	61 9	64.8	66.6	67.7	62.7	67.6	65.6
August	61.5	61.8	63.4	64.9	64.3	62.2	65.0	64 9	63.5
Mean	63.7	64.4	63.2	65.4	65.5	64.8	64.5	65.1	64.6
September	58.1	55.9	59.1	56.1	55.6	61.3	60.6	56.9	57.9
October	39.6	46.2	44 0	44.2	48.4	49.5	41 8	43.0	44.6
November	38.1	36.8	35.3	33.9	34.8	32 7	36.8	41 6	36.2
Mean	45.3	46.3	46.1	44.7	46.3	47.5	46.4	47 2	46.2
Yearly mean	44.9	46.0	44.0	43.9	43.1	45.5	43.2	45.4	44.5

taken at about one mile, although, as shown on Plate A, it narrows in two or three places to a much less width than this. This valley is now a good agricultural region, generally in a fair state of cultivation, and presenting on the whole as favorable conditions for farming as any similar valley in the State. The Western New York and Pennsylvania railway passes through the middle of the valley on the line of the abandoned Genesee Valley canal. The reservoir project includes the relaying of this railway above the flow line on the west side of the valley, as shown on Plates A and B. Inasmuch as the villages of Portageville, Rossburg, Wiscoy and a portion of Fillmore will be submerged, the project necessarily includes the purchase of the submerged portions of these villages, as well as the adjacent farm lands. The total area to be flooded below the flow line is 12.4 square miles as shown by Table No. 26. It is proposed, however, to take the land up to a height of 10 feet vertically above the ordinary flow line, making the entire area of land required 13.7 square miles.

At present there are five bridges over the Genesee river within the limits of the present reservoir — at Portageville, a mile above Portageville, at Rossburg, at Fillmore, and at two miles above Fillmore. The bridge at Portageville will be provided for by a roadway over the top of the dam itself. The bridge a mile above Portage has been constructed within the last two or three years for the accommodation purely of a number of farmers on the flats, and there will be no reason for maintaining it with the reservoir project carried out, because the farms for the accommodation of which it was erected will be included in the reservoir. The bridge at Rossburg will be moved to a location a short distance south of the present one, where the valley narrows up, presenting an opportunity to construct a bridge over the reservoir without great expense. In the same way the bridge at Fillmore, as well as the one two miles above, will be provided for by a single bridge at a point about a mile above Fillmore, where the valley narrows and the distance across the reservoir will only be a few hundred feet. The location of these proposed new bridges is shown on Plate A.

TABLE No. 13.

Mean monthly temperatures at Alfred Centre from June, 1889, *to November,* 1896, *inclusive.*

(F°.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	......	33.9	21.1	*33.8	19.8	25.4	29 7	29.9	27.6
January	......	32.0	28.8	18.0	13.8	27.5	20 4	21.6	22.4
February	......	30.9	27 9	25.6	20.0	19 7	16.4	21.7	23.2
March	......	26.2	28.8	24.2	27.3	37.2	29.4	21.6	27.8
April	......	43.7	44.9	39.8	39.7	41.7	44.2	47.3	43.0
May	......	52.2	52.4	52.1	52.9	54.2	58.8	59.5	54.6
Mean	......	36.5	33.2	32.2	28.9	34.3	33.2	33.6	33.1
June	61.5	64.7	63.4	66.9	65.6	65.5	69.8	61.4	64.8
July	66.9	65.6	61.9	67.2	67.6	68.7	65.8	66.2	66.2
August	60.9	62.2	63.6	66.4	66.4	64.9	68.4	64 6	64.7
Mean	63.1	64.2	63.0	66 8	66.5	66.4	67.8	64.1	65.2
September	57.4	56.1	60.6	58.5	55.8	61.8	63.4	57.5	58.9
October	39.7	45.3	45.8	46.2	47.3	49.8	41.7	43.7	44.9
November	36.9	35.5	35.2	33.4	34.5	31.1	39.0	41.1	35 8
Mean	44.7	45.6	47.2	46.0	45.9	47.6	48.0	47.4	46.5
Yearly mean	......	45.7	44.1	44.3	42.6	45.6	45.5	44.7	44.6

There are also a number of cemeteries in the valley which will necessarily be removed as a part of the reservoir project. Probably this is the most delicate of the several changes to be made here, but in view of the fact that cemeteries have been removed for various reasons in a number of the cities of the State, as, for instance, from the present location of the city hospital at Rochester, and the present location of Washington Park, Albany, it is not considered that this particular feature presents any special difficulties. Streets have also been opened by cities through cemeteries when necessary for the public convenience, as in a recent case in the city of Utica. Moreover, the city of New York now actually has in process the removal of a number of cemeteries in the valley of the Croton river above the location of the new Croton dam now building. Without having made a detailed canvass, it is estimated from general knowledge of the situation that the present population of the proposed Portage reservoir site, in the villages and on the farms, is about 1,200; and, in reference to dispossessing

* Missing from record. Mean of South Canisteo and Angelica used.

[illegible]

this number of people of their homes for the purpose of creating a large storage reservoir, it may be said that such a proceeding is not only not uncommon in this State, but that the population to be moved in the case of the new Croton reservoir is far greater than at the Portage reservoir. According to maps furnished by the Croton Water Department for the information of the State Engineer's Department, in the preparation of the Genesee storage project, it appears that the new Croton reservoir requires the taking of either the whole or parts of something like three large villages and nine or ten hamlets. The total population to be removed from the submerged area of the new Croton reservoir is not given, but very casual inspection of the maps of the proposed site indicates that it must be several times greater than the number to be dispossessed in case of the Portage reservoir. The villages of Katonah, Purdy's Station and Croton Falls are much larger than any of the villages in the Portage reservoir. The main line of the Harlem division of the New York Central and Hudson River railroad passes for several miles through the valley, and will require relocating, the same as is proposed for the Western New York and Pennsylvania railway along the Portage reservoir. It appears, therefore, that the city of New York is now doing, under State laws, everything in the way of so-called radical change which it is proposed to do at Portage. It would seem, therefore, that what the State has empowered one of its municipalities to do could be easily done by the State itself.

THE ANCIENT GENESEE LAKE.

One feature of the Portage reservoir of considerable interest may be now referred to, namely, that the construction of this reservoir is merely a reproduction of an ancient lake which formerly occupied the present valley of the Upper Genesee. The evidence as to the existence of this lake may be seen on every hand, particularly in the fine benchings at the sides of the valley for nearly the whole distance from Portageville to Houghton. In order to cover

TABLE No. 14.

Mean monthly temperatures at Friendship and Humphrey, 1889 *to* 1890, *inclusive.*

(F°.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	†29.6	*37.0	*23.9	*35.0	*24.2	27.8	‡29.2	30.2	29.6
January	27.8	*34.2	*27.2	*21.4	15.8	29.2	18.5	23.3	24.7
February	19.9	*33.2	*30.0	*27.7	21.5	21.0	14 0	23.9	23.9
March	35.7	*28.7	*30 0	*26.8	29.8	38.5	28.0	23.3	30.1
April	44.3	*45.2	*46.0	*42.2	41.1	42.7	45.2	47.6	44.3
May	56.3	*54 1	53.2	*53.2	53.5	54.8	57.7	62.0	55.6
Mean	35 6	38.7	35.0	34.4	31.0	35.7	32.1	35.1	34.7
June	61.8	*67.1	*66.1	*67.2	66.4	64.0	67.4	62.1	65.6
July	67.4	*67.8	*63 4	*68.1	66.5	67.4	63.8	68.2	66 6
August	61.8	*63.8	65.2	*66.5	66.2	63.2	66.2	65.6	64.6
Mean	63.7	66.2	64.9	67.3	66.4	64.9	65.8	65.3	65.6
September	*60.4	*59.3	*63.5	*59.3	57.0	61.6	61.2	58.0	60 0
October	*44.1	*47.7	*47.4	*48.3	50.4	49.3	41.8	44.0	46.6
November	*39.8	*38 8	*37.0	*34.3	36 7	32.6	38.2	42.0	37.4
Mean	48.1	48.6	49.3	47.3	48.0	47.8	47.1	48.0	48.0
Yearly mean	45.7	48.1	46.1	45.8	44.1	46.0	44.3	45.7	45.7

the various geological questions involved, not only with reference to the ancient lake, but also for comparison as to relative value for foundations of dams at Mount Morris and at Portage, Mr. J. M. Clarke, Assistant State Geologist, was, with the permission of the Honorable State Engineer and Surveyor, requested to make such examination as he might find necessary for elucidating the various practical questions presented, and to prepare a special report thereon for the information of this Department. Mr. Clarke's report, as herewith appended, is so lucid on the various questions of economic geology involved as to render extended discussion on the part of the present writer unnecessary. That part of the subject is, therefore, mostly passed with a simple reference to Mr. Clarke's report, and we may proceed to the consideration of another phase of the subject.

* Humphrey records. Friendship missing for these months.

† Missing from record. The mean of all the Decembers given has been used.

‡ Missing. Mean of Humphrey and Angelica used.

THE MOUNT MORRIS AND PORTAGE PROJECTS CONTRASTED.

With the proposed Genesee storage located in the Mount Morris canyon, the benefits to be derived from an increase in the water power, aside from the present power at Mount Morris and a few feet head at Geneseo and York, are confined entirely to the city of Rochester. The head at Mount Morris varies from 13 to 16 feet. From Mount Morris to Rochester the river flows, for a distance of 37 miles, mostly through alluvial flats, with no opportunity for developing water power, the only exception being the head of 5 feet at Geneseo and 6 feet at York.*

We have already seen that the mean water surface elevation at the dam of the Mount Morris Hydraulic Power Company may be taken at 582 feet above tide water. The elevation of the feeder dam in the south part of the city of Rochester is 510 feet, leaving a total fall from Mount Morris to the feeder dam of 72 feet. Of this, 16 feet is included in the Mount Morris water power, 5 feet at Geneseo and 6 feet at York, making a total for the three powers of 27 feet. The balance of the fall, from Mount Morris to Rochester, amounts to (72 — 27) =45 feet, or only about 1.3 feet to the mile, altogether too small an amount to afford any opportunity for development of water power in that part of the river. At Rochester we have the following:

	Feet.
Elevation of feeder dam	510
Lake Ontario	247
Total fall	263

Of which 255 feet are fairly available for water power.

As shown on page 669, the available fall from the brink of the Upper fall at Portage to the dam of the Mount Morris Hydraulic Power Company is 500 feet, of which 290 feet is included in the three falls at Portage and the short stretches of rapids between them.

*See Statistics of Power and Machinery Employed in Manufactures. By Professor W. P. Trowbridge. Report on the Water Power of the United States. Part I. Tenth Census. Washington, 1880. pp. 464-67.

TABLE No. 15.

Mean monthly temperatures of the upper Genesee drainage area, for the water years 1889 *to* 1896, *inclusive.*

[As derived by combining Tables Nos 12, 13 and 14.]

(F°.)

MONTH.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	32.5	35.1	22.1	34.0	22 2	26.8	29.0	30.1	29.0
January	27.8	32.7	25.4	19.6	14.5	28.4	19.1	22.4	23.7
February	18.4	31.8	28.5	26.5	20.9	20.1	14.5	22.9	22.9
March	34.0	27.2	29.4	24.9	28.9	37 9	28.0	22.7	29.1
April	43.8	43.9	45.3	41.0	41.0	42.1	44.2	47.7	43 6
May	56.4	53.2	52.3	52.8	53.0	54.5	57.8	60.7	55.1
Mean	35.5	37.3	33.8	33.1	30.1	35.0	32.1	34.4	33.9
June	61.8	65.8	64.6	66.9	65.8	64.6	67.5	62.1	64.9
July	67.2	66.4	62.4	66.7	66.9	67.9	64.1	67.3	66.1
August	61.4	62.6	64.1	65.9	65.6	63.4	66.5	65.0	64.3
Mean	63.5	64.9	63.7	66 5	66.1	65.3	66.0	64.8	65.1
September	58.6	57.1	61.1	58 0	56.1	61 6	61.7	57.5	58.9
October	41.1	46.4	45 7	46.2	48.7	49.5	41.8	43.6	45 4
November	38 3	37.0	35.8	33.9	35.3	32.1	38.0	41.6	36.5
Mean	46.0	46 8	47.5	46.0	46.7	47.7	47.2	47.6	46 9
Yearly mean	45.1	46.6	44.7	44.7	43.2	45.7	44.3	45.3	44.9

As shown by Tables Nos. 29 and 30, the impounding of 15,000,000,000 cubic feet of water, as proposed by the Portage reservior, will, in a year of minimum flow, effect a nearly absolutely perfect regulation of the stream. Referring to Table No. 30 we see that in the low water period from June, 1894, to November, 1896, inclusive, a period of two and one-half years, the Portage reservoir would have overflowed only three times, the total loss amounting to 2.11 inches. While it is, of course, evident that the loss would be greater than this in years of more plentiful flow, still we may accept the proposition as fairly true that such a reservoir will afford substantially complete regulation of the upper portion of the stream from year to year. It follows, therefore, that there will be only occasional floods flow through the canyon, hence low dams from 15 to 25 feet in height can be cheaply built for the whole distance from Portage to Mount Morris, utilizing for the production of power practically every foot of the 500 feet fall between these points. In these days of efficient and cheap power, transmission either by teledynamic process, compressed air or electricity,

the fact that the dams themselves are situated in a nearly inaccessible canyon has no special significance. The power developed may be easily and cheaply transmitted to every village of the surrounding country within a radius of from 20 to 30 miles. It may also be transmitted to Mount Morris, where, by reason of the intersection of three of the leading railways of the State, fine transportation facilities exist and a large manufacturing town built up at that place. Again, the concentration of nearly 300 feet of fall within a distance of two or three miles, at Portage, as well as the location of two railways there, would indicate the probability of the growth of a considerable manufacturing town in the immediate

TABLE No. 16.

Precipitation at Little Genesee, Allegany County, New York, for the water years 1866 *to* 1874, *inclusive.*

(In inches.)

MONTH.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	Mean.
December	......	3.23	2.05	2.45	2.50	2.98	5.52	2.84	3.31	....
January	0.82	1.90	2.00	2.65	5.07	3.78	1.84	5.27	*2.92	....
February	1.07	2.35	1.88	2.06	3.08	2.86	2.54	3.27	5.48	....
March	......	1.70	2.60	2.05	4.04	4.86	3.07	5 08	2.65	....
April	......	1.95	1.74	1.65	2.43	2.39	1 32	4.20	5.45	....
May	......	8.70	2.65	2.95	1.42	1.64	2.00	2.93	1.35	....
Total	......	19.83	12.92	13.81	18 54	18 51	16.29	23.59	21.16	18.08
June	1.75	1.50	3.95	4.06	4.57	3.62	3.26	3.74	4 06	....
July	1.87	3.30	1.90	6.13	8.86	3.32	5.07	4.02	4.28	....
August	0.48	4.00	1.65	2.46	3.21	3.48	3.81	3.35	2.80	....
Total	4.10	8.80	7.50	13.65	16.64	10.42	12.14	11.11	11.14	10.61
September	3 50	2.02	2.95	4.75	3 54	0.50	3 90	1.93	3.91	....
October	2.25	1.10	2.25	2.06	2.13	2.10	5.87	7.01	0.80	....
November	4.30	0.60	2.25	3.00	3.15	3.83	2 61	3.85	3.95	....
Total	10.05	3.72	7.45	10.81	8.82	6.43	12.38	12.79	8.66	9.01
Yearly total	......	32.35	27.87	38.27	44 00	35.36	40.81	47.49	40.96	38.39

vicinity. Inasmuch as the waters of the Upper Genesee are mostly sanitarily unobjectionable, the water supply of such a town would naturally be arranged with reference to taking water from the dam itself, where the continuous discharge of the minimum quantity of 457 cubic feet per second would provide an efficient water power for raising the water to the site of the future manufacturing town.

* No record. Mean of eight years used.

Without going into the exact figures as to the final value to the Commonwealth of such extensive developments as are here suggested, it is enough to say that there can be no doubt but that either a private company or the State itself would reap vast profits from the carrying out of the proposed reservoir on the basis and in the manner here pointed out.*

On the other hand, the location of the dam in the Mount Morris canyon not only cuts down the commercial benefits to be derived from the proposed storage, but also prevents the development of any great amount of power at Mount Morris, which is the chief village within the immediate vicinity of the proposed sites. As shown by Tables Nos. 27 and 28, a dam located at Mount Morris

TABLE No. 17.

Mean temperature at Little Genesee, Allegany county, New York, for the water years, 1866 *to* 1874, *inclusive.*

(F°.)

MONTH.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	Mean.
December	†24.0	23.6	23.4	22.1	27.6	25.6	22.6	18.0	29.2	......
January	20.5	16.5	18.9	27.1	27.7	23.7	21.2	20.2	†22.0	......
February	24.0	30.0	17.2	25.2	21.4	25.6	21.0	21.0	22.8	......
March	28.9	29.9	32.6	25.1	26.7	37.9	21.6	27.3	30.2	......
April	47.0	44.4	38.0	42.2	44.6	46.8	43.1	40.2	34.3	......
May	50.2	49.2	52.4	52.6	57.4	52.3	52.4	51.8	56.2	......
Mean	32.4	32.3	30.4	32.4	34.2	35.3	30.3	29.7	34.1	32.3
June	64.2	67.6	63.8	63.3	68.4	63.4	65.3	65.4	61.5	......
July	70.2	67.1	73.6	66.4	67.5	65.2	69.0	67.4	69.5	......
August	59.8	66.2	67.2	65.2	66.4	68.0	68.2	65.4	62.8	......
Mean	64.7	67.0	68.2	65.0	67.4	65.5	67.5	66.1	64.4	66.2
September	57.3	58.5	58.8	59.0	58.9	52.7	58.9	56.7	61.8	......
October	47.4	46.3	44.6	39.4	48.6	47.0	45.0	44.0	46.0	......
November	38.5	38.0	36.7	29.8	35.0	30.6	31.0	28.3	33.3	......
Mean	47.4	47.6	46.7	42.7	47.5	43.4	45.0	43.0	46.9	45.6
Yearly mean	44.3	44.8	44.0	43.1	45.8	44.9	43.3	43.1	44.9	44.1

*Relative to the foregoing remark as to the profits of a private company it will of course be understood that under the present laws of the state of New York no private company could be organized with such franchise as would permit of carrying out a broad scheme of power development and the building up of a manufacturing town in the manner suggested. Before that could be done it would be necessary for the State to release its assumed right to the waters of the Genesee river. In regard to the possible value to the State itself of the development which would inevitably follow the construction of this dam, reference may be made to a paper—Genesee River Storage and Its Relations to the Erie Canal and the Manufacturing Interests of Western New York, as prepared by the author for the Rochester Chamber of Commerce, in October, 1895.

† No record. Mean of eight years used.

will inevitably be drawn completely out in the year of minimum flow. This contingency prevents the development of any water power at the dam itself, and the production of power at Mount Morris is, with the dam located there, limited to the present fall of from 13 to 16 feet. Hence, with the storage dam located at Mount Morris no special benefit accrues to that place except such a temporary one as may arise from the sale of supplies during the construction period.

PARK AT PORTAGE AND WAGON ROAD AROUND THE RESERVOIR.

The Portage falls and gorge are now the second great natural curiosity of the State of New York. If we construct the Portage reservoir, with its dam rising to the height of 118 feet, we add greatly to the natural attractions of what is already a famous place for tourists. In view of the great natural interest, the author can not but think that the canyon, from Mount Morris to Portage, should be purchased by the State for park purposes. The location of artistically designed power stations throughout the canyon would not in any way injure the natural scenery. At any rate, by retaining the proper control, the State can direct the design of such stations, making them, if desirable, not only no injury, but even an addition to the scenery by proper architectural treatment. On this line, the final outcome would be the construction of a State road entirely around the canyon, as well as the new reservoir. In any case, the author deems it desirable that where the State constructs large storage reservoirs, it should make the roads as a necessary part of the project, and the cost of such a road has accordingly been included in the present estimates. By treating the subject broadly in this way the State comes nearer to making such projects of interest and value to every citizen than in any other way.

AS TO THE SAFETY OF THE NATURAL BANKS.

The objection has been raised that the banks of the Portage reservoir, just east of the Erie railway station at Portage, would not be entirely safe with water raised to the height as proposed of 118

TABLE No. 18.

Precipitation at Le Roy from 1891 *to* 1895, *inclusive.*

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	Mean.
December	5.22	4.21	3.26	6.48	3.34	4.49
January	4.12	6.80	3.95	4.91	5.82	5 12
February	7.10	5.33	6.86	6.66	4.55	6.10
March	7.40	4.52	3.90	2.32	2.40	4.11
April	2.22	1.47	3.82	4.96	2.73	3.04
May	1.95	4.91	6.13	6.94	3.05	4.60
Total	28.01	27.24	27.92	32.22	21.89	27.46
June	4.96	4.91	0.50	3.48	3.63	3.49
July	6.10	3.40	3.67	2.22	1.93	3.46
August	5.33	3.95	4.89	0.96	1.65	3.36
Total	16.39	12.26	9.06	6.61	7.21	10.31
September	1.71	1.17	4.33	2.72	1.89	2.36
October	1.44	1.60	2.35	3 62	2.04	2.21
November	3.40	4.33	1.75	2.18	2.89	2.91
Total	6.55	7.10	8.43	8.52	6.82	7.48
Yearly total	50.95	46.60	45.41	47.35	35.92	45.25

feet above the present river bed. On referring to Plate A, it will be seen that what is known as the Portage peninsula runs out to the west, leaving a comparatively narrow neck a short distance east of the Portage station of the Erie railway. As to the safety of this narrow neck, the map is, however, very reassuring, indicating, as it does, a width of about 1,400 feet at the high water level. As remarked by Mr. Clarke, in his report, the best evidence that the banks of the proposed Portage reservoir will be water tight is the fact that they are undoubtedly the banks of an ancient lake. The benches on the sides of the valley, some of which are shown in Plates Nos. XXV, XXVI and XXVII indicate that the lowering of the water was very gradual. As to how it chanced, we may imagine that the stream flowed for many years over a lip of rock at the head of the gorge, which, wearing thinner and thinner, from year to year, finally at some time of flood flow, broke through, giving a sudden lowering of the waters of several feet. The ordinary surface of the lake remained then for a long series of years at substantially the same elevation, until the rock lip had again grown thin, and, finally, in some time of flood again broke through, giving another lowering of several feet; and so on through

many thousand of years until the present level was reached. However, in order to test the water-holding properties of the neck of the peninsula thoroughly, a number of borings were made along the present bank opposite the neck, with the result of showing in every case that the material was either compact clay or sand and clay mixed in such proportions as to indicate excellent water-holding properties. As the result of these borings, and of the general information gained, it is the opinion of the writer that there is no possibility of any trouble from the banks of the reservoir at the point mentioned, although it may be stated that there is a tradition of a tunnel having been begun for the old Genesee Valley

TABLE No. 19.

Precipitation at Arcade from 1891 *to* 1896, *inclusive.*

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	1.64	4.09	1.51	3.82	2.06	3.92	2.84
January	1.82	2.52	1.69	3.12	3.79	2.35	2.55
February	4.04	2.35	4.60	2.50	0.99	3.86	3.06
March	1.87	1.77	2.64	1.83	1.09	3.50	2.12
April	1.32	1.84	4.47	6.02	1.51	1.36	2.67
May	1.87	7.16	7.28	10.05	1.90	2.48	5.12
Total	12.56	19.23	22.19	27.34	11.34	17.47	18.36
June	4.69	9.33	3.63	5.35	4.04	3.19	5.04
July	5.11	4.59	2.88	2.70	2.38	6.39	4.01
August	5.00	4.78	6.55	1.57	5.71	3.77	4.56
Total	14.80	18.70	13.06	9.62	12.13	13.35	13.61
September	2.36	2.59	3.19	5.54	1.61	6.18	3.58
October	2.16	3.63	3.77	4.62	2.26	3.22	3.28
November	3.10	3.33	1.95	1.82	2.77	3.68	2.77
Total	7.62	9.55	8.91	11.98	6.64	13.08	9.63
Yearly total	34.98	47.48	44.16	48.94	30.11	43.90	41.60

canal through this neck about 1838, and abandoned because of the presence of quicksand. On this point the writer suggests that the engineers and contractors of sixty years ago were much better versed in the moving of rock than they were in working either quicksand or earth in tunnel, and, probably, the fact that the cutting of the prism of the Genesee Valley canal along the river bluff, keeping it almost entirely in open rockwork, made so much easier

work than a tunnel through earth, was really the controlling condition of the final location. The author does not believe there is any material in that vicinity which would seriously interfere with the construction of a tunnel, with the appliances which we have for doing such work at the present day. In 1838, on the contrary, the art of tunneling in earth was, so far as the United States is concerned almost absolutely unknown. While even at that early day such work had been frequently done abroad, American engineers had as yet no experience at it. The tradition, therefore, of the proposed tunnel through the neck of the Portage peninsula and its abandonment by reason of meeting quicksand has, in the writer's opinion, no special significance in considering the merits of the present project.*

IMPROVEMENT IN WESTERN NEW YORK AND PENNSYLVANIA RAILWAY LOCATION.

Passing to another division of our subject, we may remark that the relocation of the Western New York and Pennsylvania railway on the west side of the valley above the flow line will, on the whole, lead to a considerable improvement of that portion of the railway. Again, while the villages of Portageville, Rossburg, Wiscoy and part of Fillmore will be submerged, still the inevitable development of the water power which will follow the construction of the reservoir will, in a few years, make far more business for the railroad than is now furnished by these small villages. It must be concluded that the change will, as a whole, be greatly to the benefit of the railway.

*The official history of the proposed Portage tunnel may be obtained by consulting (1) a Report on a Survey of the Genesee Valley Canal, by F. C. Mills, in Ass. Doc. No. 42, 1836, pp. 14-15, where Mr. Mills gives the result of sinking test pits on the line of the proposed tunnel; (2) a Report Relative to the Genesee Valley Canal, also by F. C. Mills, in Ass. Doc. No. 73, 1837, pp. 74-75, where Mr. Mills gives further accounts of test pits and borings on the line of the proposed tunnel. As the result of these further examinations Mr. Mills found good water-tight material, but abandoned the tunnel project chiefly because there was no rock through which to drive it. In the center of the Portage peninsula Mr. Mills found only thin layers of what he called quicksand at about the water level of the proposed reservoir. Below that level he found the best of water-holding material—compact clay. Mr. Mills's work in 1836, therefore, verifies the work of 1896 in a very satisfactory manner. This matter of the proposed Portage tunnel is also referred to in subsequent reports of the Canal Commissioners, but all the reports indicate that the engineers of 1836, were unwilling to undertake earth tunnels—their preference was for rock work.

TABLE No. 20.

Precipitation at Avon and Mount Morris, from 1891 *to* 1896, *inclusive.*

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	1.05	3.96	0.86	2.09	2.54	2.50	2.17
January	1.99	2.14	0.55	2.58	3.31	2.60	2.19
February	2.88	2.45	2.86	2.78	1.47	5.35	2.97
March	3.63	0.63	2.62	0.97	1.53	3.23	2.10
April	1.13	0.70	2.18	4.13	1.62	0.46	1.70
May	1.63	4.08	4.00	6.27	1.48	1.66	3.19
Total	12.31	13.96	13.07	18.82	11.95	15.80	14.32
June	3.67	7.77	1.02	2.08	2.67	2.82	3.34
July	3.94	2.53	1.97	1.51	1.74	4.91	2.77
August	3.03	4.61	5.20	2.27	3.41	1.85	3.39
Total	10.64	14.91	8.19	5.86	7.82	9.58	9.50
September	1.42	1.16	2.95	4.28	1.84	3.94	2.60
October	2.46	1.42	1.88	2.57	0.84	1.41	1.76
November	1.50	3.27	1.10	0.54	2.60	2.60	1.94
Total	5.38	5.85	5.93	7.39	5.28	7.95	6.30
Yearly total	28.33	34.72	27.19	32.07	25.06	33.33	30.12

REASONS IN DETAIL FOR PREFERRING PORTAGE.

We may now consider further the reasons for preferring the Portage site to Mount Morris, urging in brief the following:

(1) The Portage site affords more water for a given expenditure.

(2) The Portage site is much safer than at Mount Morris. As shown in the 1893-94 reports, the shales at Mount Morris are open, and, while it is, without doubt, possible to make a safe dam there, still, it would be at much greater cost than at Portage. In any case the dam must be absolutely safe, as its failure would work vast destruction.

(3) The material for dam is mostly on the ground at Portage, whereas at Mount Morris it necessarily requires to be all brought from a distance. This phase of the question has been so thoroughly discussed in the previous reports as to render any further consideration of it unnecessary here.

(4) Great increase in the water power development. As we have seen, with the dam at Mount Morris, the total head on which the storage can be applied is $(16+5+6+255)=282$ feet, whereas with

the dam at Portage the total head on which the stored water may be applied is 782 feet. What this means in the way of commercial value of the storage will be shown further on.

(5) On account of great depth of foundation at Mount Morris it would be necessary to expend over $1,000,000 before the dam could be brought to the level of the present water surface. The conditions are such that the floods of every spring would sweep over the work, obliterating all evidence that any money had been expended, and this must necessarily continue for at least two or three years, until the foundations are fully placed. The chances are good, therefore, that after some particularly severe flood, not only the Legislature, but even the friends of the project might become discouraged and the work left uncompleted, whereas at Portage, with a good foundation near the water level, the expenditure shows for itself from the first. An expenditure of $100,000 there would show at the end of the season further towards actual completion of the work than $1,000,000 in two seasons at Mount Morris.

MOUNT MORRIS AND PORTAGE RESERVOIRS COMPARED COMMERCIALLY.

Having disposed of the preliminary phases of the discussion, let us now compare the Mount Morris project with the Portage by way of determining the commercial value of the two. As shown in the report on the Water Supply of the Western Division of the Erie Canal, with the enlarged Erie canal fully completed, the State will require from the Genesee river for canal purposes 80 cubic feet of water per second in all the months of the navigation season, from May to November, inclusive, except the month of May, when 177 cubic feet per second will be required. As regards the present discussion, we will leave the valuation of the water required by the State out of the account and base our estimate on the value of the water power to be created purely.*

With a reservoir at Mount Morris storing 7,340,000,000 cubic feet, we have 282 feet fall on which the 7,340,000,000 cubic feet, less the quantity required for the canal, may be applied for power

*This part of the subject will be discussed further on.

TABLE

Precipitation at Middlebury Academy, Wyoming Coun

(In in

MONTH.	1826.	1827.	1828.	1829.	1830.	1831.	1
December	†1.79	0.44	2.80	1.74	2.85	2.13	
January	1.90	1.60	1.30	1.08	1.73	1.45	
February	1.03	3.26	2.12	1.48	0.38	1.08	
March	3.16	2.86	1.62	1.02	3.08	1.44	
April	1.77	3.84	1.97	2.63	2.43	3.66	
May	0.33	1.48	6.17	3.50	4.46	2.50	
Total	9 98	13.48	15.98	11.45	14.93	12.26	
June	4.22	2.94	3.05	3.18	8.63	4.39	
July	3.13	2.17	4.52	3 74	3.89	5.00	
August	1.78	2.95	6.69	1.28	2.28	2.85	
Total	9.13	8.06	14.26	8.20	14.80	12.24	
September	1.12	1.24	2.12	3.71	3.29	1.83	
October	2.58	4.38	2.31	2.22	1.55	3.89	
November	2.50	0.70	4.81	3.11	4.65	1.18	
Total	6.20	6.32	9.24	9.04	9.49	6.90	
Yearly total	25.31	27.86	39.48	28.69	39.22	31.40	

* From the Regents' reports. † No

No. 21.

y, N. Y., for the years indicated from 1826 *to* 1848.*

hes.)

2.	1833.	1834.	1835.	1840.	1841.	1842.	1843.	1844.	1845.	1848.	Mean.
0.56	0.65	1.16	0.80	†1.79	2.03	4.30	2.26	2.24	1.11	†1.79	1.79
1.51	1.64	1.45	1.48	1.25	2.60	1.42	1.25	0.62	1.55	0.99	1.46
4.63	1.72	0.71	1.58	3.25	0.12	2.10	3.60	0.46	2.45	0.20	1.78
1.73	0.50	2.86	2.25	2.38	4.25	3.25	1.94	2.92	2.90	0.83	2.29
2.10	2.12	2.45	3.75	1.41	3.40	1.85	3.78	1.78	2.48	0.35	2.46
4.37	6.58	1.41	1.74	1.80	2.30	1.55	1.74	4.27	2.10	4.35	2.98
4.90	13.21	10.04	11.60	11.88	14.70	14.47	14.57	12.29	12.59	8.51	12.76
1.11	2.46	4.45	5.78	4.19	1.85	2.74	3.29	2.75	1.79	1.07	3.41
1.85	3.83	3.69	2.00	4.70	2.30	0.51	1.64	5.58	2.47	5.13	3.30
3.80	2.94	1.92	4.49	4.47	0.57	1.87	2.17	4.65	0.56	2.50	2.81
6.76	9.23	10.06	12.27	13.36	4.72	5.12	7.10	12.98	4.82	8.70	9.52
3.24	2.94	2.54	2.15	2.94	4.40	4.93	4.81	0.64	3.61	2.64	2.83
1.54	3.01	3.32	6.69	2.34	1.85	2.36	3.99	4.45	2.10	1.51	2.95
4.24	1.77	1.84	1.85	1.66	3.55	3.15	2.46	1.67	2.89	1.40	2.55
9.02	7.72	7.70	10.69	6.94	9.80	10.44	11.26	6.76	8.60	5.55	8.33
0.68	30.16	27.80	34.56	32.18	29.22	30.03	32.93	32.03	26.01	22.76	30.61

cord. **Mean of all the Decembers used.**

purposes. The general result is indicated by Table No. 27. Referring to that table, we learn that in a year of minimum flow such as the water year of 1895, a storage of 7,340,000,000 cubic feet would only produce a regulated flow, aside from the water required for canal purposes, of 600 cubic feet per second. The constant outflow from the reservoir being under these conditions, as shown by Column 10 of Table No. 27, never less than 300 cubic feet per second. Continuous power development would, therefore, be based upon 300 cubic feet per second at Mount Morris, something greater than this at Geneseo and York, and on 600 cubic feet per second at Rochester. What we require to know is the value of the water power to be perpetually produced by this quantity of water on the stated fall. As the first element of the solution, we have at Mount Morris the permanent continuous power of 300 cubic feet per second on 16 feet head, equal to 544.6 gross horse power.

At Geneseo and York we have the low water flow of an additional tributary drainage area of about 400 square miles,* which may be taken at 0.1 cubic feet per second per square mile, as derived from the experience of the gagings at Mount Morris, whence the permanent flow of these two places is placed at 340 cubic feet per second. The sum of the two heads at the two places is (5 + 6) = 11 feet. The gross horse power is, therefore, 424.3.

At Rochester the total power developed will be that due to 600 cubic feet per second on 250 feet head, which amounts to 17,358.5 gross horse power. We have, then, a total permanent continuous power from Mount Morris to Rochester of 18,327 gross horse power.

As regards the increase in water power, the effective value of the storage will be the amount of permanent power over and above the low-water power of the stream. Taking the low-water run-off at 100 cubic feet per second at Mount Morris, 140 cubic feet per second at Geneseo and York, and 220 cubic feet per second at Rochester, we have a total permanent power for the unregulated stream of 6,727 gross horse power. The gain due to the storage is, therefore (18,327 — 6,727) = 11,600 gross horse power. Taking the

---

*The drainage areas of the Canaserga and Cushqua creeks, the chief tributaries immediately below Mount Morris, amount to 340 square miles.

price at $10 per horse power, the same as in the Upper Hudson reports,* and we reach an annual return from the increased power of $116,000. But the Mount Morris reservoir is, as shown on page 638, estimated to cost $2,785,000. If we assume the project carried out by a private company with money at 5 per cent., the annual interest on the investment becomes $139,250, a sum $23,250 in excess of the probable annual income when all the power created shall have been brought into use. But there should be a sinking, maintenance and repair fund of at least $25,000 per year in order to ultimately repay the principal investment, which, if taken into account, increases the probable deficiency to $48,250 per year.

On the other hand, let us assume the Mount Morris project carried out by the State with money costing not more than 4 per cent. In this case we have an annual interest on the investment of $111,400. Adding thereto $25,000 for sinking fund, maintenance and repairs and we reach a total of $136,400, a sum still in excess of the probable maximum income of $20,400.

It must be concluded, therefore, that with the present understanding as to the minimum runoff of the Genesee river, the project of a storage reservoir in the Mount Morris canyon, storing 7,370,000,000 cubic feet of water, at a cost of $2,785,000 is commercially impracticable.

If, however, we consider the Portage project in its financial aspects we reach the following results:

As shown by Table No. 29, the constant minimum outflow from the Portage reservoir has been placed at 457 cubic feet per second. Inasmuch as there is no material addition to the tributary drainage area between Portage and Mount Morris, we may consider this quantity as applying to the entire 500 feet fall from the crest of the upper fall at Portage to the crest of the dam of the Mount Morris Hydraulic Power Company. With the additional area due to Silver lake outlet, we may take the flow over the Mount Morris dam at 460 cubic feet per second,† Geneseo and York may be taken

*See report on Upper Hudson Storage in the Annual Report of the State Engineer and Surveyor for the fiscal year ending Sept. 30, 1895, p. 146.

†That is Silver lake outlet, which enters the Genesee river a short distance above Mount Morris, contributes 3 cubic feet per second to the minimum flow.

TABLE

Mean temperatures at Middlebury Academy, Wyoming C

MONTH.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.
December	†29.2	29.5	29.8	36.2	37.6	32.4	18.0	34.3
January	25.4	21.9	31.5	25.1	23.2	21.1	25.8	31.2
February	29.4	30.7	35.7	19.6	26.5	20.8	24.8	25.4
March	36.4	35.8	39 8	29.9	36.0	38.9	34.7	33.9
April	39.7	47.8	41.2	46.8	50.8	46.3	43.5	51.8
May	61.1	52.6	57.0	59.2	52 9	56.5	54.6	61.5
Mean	36.9	36.4	39.2	36.1	37.8	36.0	33 6	39 7
June	67.4	62.9	68.5	64.8	61.0	68.8	65.6	61.2
July	68.2	68.0	66 9	65.7	70.2	69.9	69.9	69.0
August	64.5	65.0	69.5	66.3	65 3	68.1	68.5	67.2
Mean	66.7	65.3	68 3	65.6	65.5	68.9	68.0	65.8
September	60.6	58.1	59 4	55.1	58.4	59.6	60.7	62.0
October	51.7	47.8	49.4	50.9	52.1	52.3	51.9	49.3
November	38.4	34.1	44.9	35.4	45.8	35.7	39.6	39.4
Mean	50.2	46.7	51.2	47.1	52.1	49 2	50.7	50 2
Yearly mean	47.7	46 2	49.5	46.2	48.3	47.5	46 5	48.8

* From the Regents' reports. † No re

No. 21 A.

ounty, N. Y., for the years indicated from 1826 *to* 1848.*

F°.)

1834.	1835.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1848.	Mean.
33.5	27.8	†29.2	31.0	20.4	25.9	24.7	30.0	29.6	22.2	†29.2	29.0
25.6	26.8	26.3	20.6	25.0	24 5	30.0	19.2	27.4	38.3	30.3	26.3
38.4	19.1	28.2	31.5	20.5	29.5	15.4	27.3	27.6	22.2	26.8	26.3
36.9	32 4	33 1	33 3	28.0	37.7	21.2	33.0	36.4	34.7	33.2	33.9
49.9	43.0	50.6	45.6	25.2	44.5	45.9	54.2	47.0	47.1	45.2	45.6
55.8	56.0	55.8	57.1	50.8	50.3	53.2	59.2	53.2	59.9	59.2	56.1
40.0	34.2	37.2	36.5	28.3	35.4	31.7	37.2	36.9	37.4	37.3	36.2
63.0	64.5	59.3	62.7	66.4	60.0	61.6	63 1	63.2	63.4	66.4	63.9
72.3	68.6	69.2	69.0	63.7	71.5	69.8	68.7	69.7	67.7	68.2	68.7
69.1	64.3	63.7	68.4	65.1	57.0	68.7	67.9	72.2	69.4	71.1	66.9
68.1	65.8	64.1	66.7	65.1	62.8	66.7	66.6	68.4	66.8	68.6	66.5
61.8	54.5	56.8	55.5	64.4	58.3	62.5	63.3	55.6	63.3	53.9	59.1
49.1	53.2	54.1	45.6	38.4	47.1	43.0	45.1	35.4	45 1	50.5	48.0
39.4	40.5	36.5	38.4	32.0	32.1	31.1	35.5	33.1	41.1	34.2	37.2
50 1	49.4	49.1	46.5	44.9	45.8	45.5	48.0	41.4	49.9	46.2	48.1
49.6	45.9	46.9	46.5	41.7	44.8	43.9	47.2	45.9	47.9	47.4	46.7

ord. Mean of all the Decembers given used.

TABLE

Mean temperatures at Middlebury Academy, Wyoming C

(

MONTH.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.
December	†29.2	29.5	29.8	36.2	37.6	32.4	18.0	34.3
January	25.4	21.9	31.5	25.1	23.2	21.1	25.8	31.2
February	29.4	30.7	35.7	19.6	26.5	20.8	24.8	25.4
March	36.4	35.8	39 8	29.9	36.0	38.9	34.7	33.9
April	39.7	47.8	41.2	46.8	50.8	46.3	43.5	51.8
May	61.1	52.6	57.0	59.2	52 9	56.5	54.6	61.5
Mean	36.9	36.4	39.2	36.1	37.8	36.0	33 6	39 7
June	67.4	62.9	68.5	64.8	61.0	68.8	65.6	61.2
July	68.2	68.0	66.9	65.7	70.2	69.9	69.9	69.0
August	64.5	65.0	69.5	66.3	65 3	68.1	68.5	67.2
Mean	66.7	65.3	68 3	65.6	65.5	68.9	68.0	65.8
September	60.6	58.1	59 4	55.1	58.4	59.6	60.7	62.0
October	51.7	47.8	49.4	50.9	52.1	52.3	51.9	49.3
November	38.4	34.1	44.9	35.4	45.8	35.7	39.6	39.4
Mean	50.2	46.7	51.2	47.1	52.1	49 2	50.7	50 2
Yearly mean	47.7	46 2	49.5	46.2	48.3	47.5	46 5	48.8

* From the Regents' reports. † No rec

No. 21 A.

ounty, N. Y., for the years indicated from 1826 *to* 1848.*

F°.)

1834.	1835.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1848.	Mean.
33.5	27.8	†29.2	31.0	20.4	25.9	24.7	30.0	29.6	22.2	†29.2	29.0
25.6	26.8	26.3	20.6	25.0	24 5	30.0	19.2	27.4	38.8	30.3	26.3
38.4	19.1	28.2	31.5	20.5	29.5	15.4	27.3	27.6	22.2	26.8	26.3
36.9	32 4	83.1	33 3	28.0	37.7	21.2	33.0	36.4	34.7	33.2	33.9
49.9	43.0	50.6	45.6	25.2	44.5	45.9	54.2	47.0	47.1	45.2	45.6
55.8	56.0	55.8	57.1	50.8	50.3	53.2	59.2	53.2	59.9	59.2	56.1
40.0	34.2	37.2	36.5	28.3	35.4	31.7	37.2	36.9	37.4	37.3	36.2
63.0	64.5	59.3	62.7	66.4	60.0	61.6	63 1	63.2	63.4	66.4	63.9
72.3	68.6	69.2	69.0	63.7	71.5	69.8	68.7	69.7	67.7	68.2	68.7
69.1	64.3	68.7	68.4	65.1	57.0	68.7	67.9	72.2	69.4	71.1	66.9
68.1	65.8	64.1	66.7	65.1	62.8	66.7	66.6	68.4	66.8	68.6	66.5
61.8	54.5	56.8	55.5	64.4	58.3	62.5	63.3	55.6	63.3	53.9	59.1
49.1	53.2	54.1	45.6	38.4	47.1	43.0	45.1	35.4	45 1	50.5	48.0
39.4	40.5	36.5	38.4	32.0	32.1	31.1	35.5	33.1	41.1	34.2	37.2
50 1	49.4	49.1	46.5	44.9	45.8	45.5	48.0	41.4	49.9	46.2	48.1
49.6	45.9	46.9	46.5	41.7	44.8	43.9	47.2	45.9	47.9	47.4	46.7

ord. Mean of all the Decembers given used.

at
sec
th

Pc
M
G
B

at 500 cubic feet per second, and Rochester at 1,000 cubic feet per second. Computing, we have a permanent, continuous power at these several places as per the following:

	Gross horse power.
Portage to Mount Morris	25,924
Mount Morris	835
Geneseo and York	624
Rochester	29,840
Total	57,223

Deducting from the total of 57,223 gross horse power the present permanent power of 6,727 gross horse power previously determined and we have (57,223 — 6,727) =50,496 gross horse power as the net increase in the permanent water power of the stream due to the construction of the Portage reservoir. At $10 per gross horse power as before, the annual income, when the power is all utilized, becomes $504,960.

The estimated cost of producing this vast increase in power is $2,600,000. Assuming an interest rate of 5 per cent. as before, and we have an annual interest account of $130,000; adding thereto $25,000 for sinking fund, maintenance and repairs, we reach a total annual expense of $155,000. Whence ($504,960 — $155,000) = $349,960, which amount may be realized in the way of ultimate annual income.

In the same way with money assumed at 4 per cent. the total annual expense may be placed at $129,000, and giving a final annual income over all expenses of $375,960.

Taking into account the total created values without reference to the cost of money, and we have the following comparison:

The Mount Morris project creates power valued at $116,000 per year. Capitalizing $116,000 at 5 per cent. gives $2,320,000. The Portage project creates water power valued at $504,960 per year, giving a capitalized value at 5 per cent. of $10,099,200. At 4 per cent. the capitalization becomes $12,624,000.

As already shown, when we take into account the value of money, the Mount Morris project not only has no value at all, but becomes commercially impracticable. The Portage project, on the other hand, shows an annual income above interest account, sinking fund, maintenance and repairs of $349,950, which, capitalized at 5 per cent., represents $6,999,000. If we assume 4 per cent. money, the capitalization of the annual income may be expected to ultimately represent $8,748,750.

It is clear from the foregoing that a much larger sum than $2,600,000 could be spent, if necessary, on the Portage project without exhausting its commercial possibilities.

WATER POWER APPRECIATING, FARMING LAND DEPRECIATING IN VALUE.

We may consider the Mount Morris project versus the Portage in another light. At the present time, because of the development of manufacturing and commercial enterprises generally, water is rapidly appreciating in value both for navigation purposes and the production of power. On the contrary, due to the development of vast farming areas in the new States of the West, where wheat may be grown much cheaper than in New York State, the value of agricultural lands is continually depreciating. The question, therefore, of taking a considerable area of land for the construction of a large storage reservoir is one of commercial expediency purely. In view of the foregoing showing as to the relative commercial advantages of Mount Morris versus Portage, as a site for the proposed Genesee storage reservoir, one can not but think, if it were finally decided to locate at Mount Morris, because of the less value of the land to be taken, that a purely business question would have been decided on sentimental grounds rather than on commercial.

LAND TO BE TAKEN FOR THE PROPOSED PORTAGE RESERVOIR.

Referring to Table No. 26, it is learned that with the water surface of the proposed reservoir raised to the level of 1,200 feet above tide water the area flowed becomes 12.35 square miles. It is proposed,

ESTIMATE OF LAND DAMAGES.

1,500 acres, at $100	$150,000
1,500 acres, at $80	120,000
1,000 acres, at $60	60,000
1,000 acres, at $40	40,000
2,500 acres, at $30	75,000
500 acres, at $25	12,500
300 acres village property, at $460	138,000
Contingency	54,500
Total, 8,300 acres	$650,000

In reference to the 2,500 acres of farming lands estimated at $30 per acre and the 500 acres estimated at $25 per acre, it may be remarked that these figures include the area to be taken on the sides of the valley, not only of little value for agriculture, but also long since denuded of valuable timber. Lands valued at $100 per acre, $80 and $60 are actual areas required for the reservoir, and do not include any surplus parts of farms over and above land to be taken for flowage. The total of $457,500 for the 8,000 acres of farming lands required is believed to be considerably in excess of the actual value of the land to be taken. In the same way, the total valuation of $138,000 placed upon the village property is somewhat in excess of the actual value of that property. Nevertheless, in order to cover all possible contingencies on condemnation, it has seemed desirable to add the sum of $54,500, making a total for the 8,300 acres of $650,000. The area included in this 8,300 acres is valued by the town assessors at about $375,000 to $400,000, as determined from the assessment-rolls of the year 1896. These valuations, it may be remembered, the assessors have sworn represent the full value of the property.

STATE REVENUE NOT APPRECIABLY REDUCED.

The question is likely to be raised as to the reduction of the State's revenue by reason of taking about $400,000 worth of realty for the proposed reservoir. In answering this we may assume the

however, to take an additional area up to 10 feet above the ordinary water level, or to 1,210 feet above tide water, making a total area at that elevation of 13.69 square miles, or 8,762 acres. This area includes farming lands, village property and the present bed of the Genesee river.

STATE OWNS THE BED OF THE GENESEE RIVER.

As to the bed of the river, it appears that the State's ownership thereof has been recognized in the deeding of the adjoining lands to low-water mark only, hence the State owns the river bed, amounting to approximately 462 acres, thus leaving the entire area to be purchased at 8,300 acres, of which 300 acres may be considered as included in the villages of Portageville, Rossburg, Wiscoy and Fillmore. We have, therefore, a total area of farms to be taken of 8,000 acres.* This area is situated in the townships of Portage, in Livingston county, Genesee Falls, in Wyoming county, and in the townships of Hume, Granger and Caneadea, in Allegany county.

VALUE OF LAND IN PORTAGE.

Referring to the proceedings of the Board of Supervisors of these counties for the year 1895, it appears that in the town of Portage the total acreage is 16,134, having a total assessed value of $716,305. The assessed value per acre is, therefore, $44.39.†

VALUE OF LAND IN GENESEE FALLS.

From the proceedings of the Board of Supervisors of Wyoming county for 1895, it is learned that the total acreage in the town of Genesee Falls is 9,500 acres, with a total assessed valuation of $342,096, whence we derive an assessed value per acre of $36.01.‡

*The 8,000 also includes the present right of way of the Western New York and Pennsylvania Railway, in regard to which see the estimates of cost of changing railway on page

† See statement showing the amount of real estate as assessed and equalized, etc., in the Proceedings of the Board of Supervisors of the county of Livingston, 1895.

‡ See Table of Assessment and Equalization, in Proceedings of the Board of Supervisors of the county of Wyoming, 1895.

VALUE OF LAND IN HUME, GRANGER AND CANEADEA.

From the proceedings of the Board of Supervisors of Allegany county for 1895, it is learned that the total acreage of the town of Hume is 24,274 acres, with an assessed valuation of $748,684, whence we derive an assessed valuation per acre of $30.84. For the town of Granger the total acreage is given at 20,450 acres, with an assessed valuation of $271,794, whence we derive an assessed valuation per acre of $13.30. For the town of Caneadea the acreage is given at 21,950, with a total assessed valuation of $451,120, whence we derive an assessed valuation per acre of $20.55.*

The foregoing acreage and assessed valuation of the several towns, include the village property as well as the farm property in each town.

STATE TAXES IN THE TOWNS.

The following are the total State taxes in the several towns in question in 1895: Portage, $2,236.17; Genesee Falls, $1,226.93; Hume, $1,945.31; Granger, $953.34; Caneadea, $1,494.40. We have, therefore, in the five towns, a portion of which will be taken for the proposed reservoir, a total area of 92,308 acres with a total assessed valuation of $2,529,900, on which, in the year 1895, the total State tax amounted to $7,856.15.

It should be understood that the total assessed valuations as here given are the assessors' valuations, and not the equalized valuations. Taking the mean of the whole we reach an average price per acre in the five towns of $27.41.

VALUE OF LANDS REQUIRED FOR THE RESERVOIR.

It may be remarked, however, that the lands required for the reservoir are, perhaps, the most valuable lands of the region, and, hence, should be properly estimated at a considerably higher value than the average value of the whole area. Recognizing the justice of this view, I have, after consultation with, and the obtaining of values from the assessors of the several towns, prepared the following schedule of values for the 8,300 acres required to be purchased, namely:

*See Equalization and Tax Table, in Proceedings of the Board of Supervisors of Allegany county, 1895.

110,000 cubic yards rock excavation, at 60 cents	$66,000
36,600 cubic yards ballast, at 40 cents	14,640
44,000 ties, at 50 cents	22,000
1,832 tons rails (70 pounds per yard), at $30	54,960
236,500 pounds angle bars, at 1.3 cents	3,075
23,650 pounds bolts, at 1.9 cents	450
94,000 pounds spikes, at 1.6 cents	1,505
16.65 miles track laying, at $400	6,600
12 switches and stands, complete, at $75	900
Cast iron pipe culverts (complete, with end walls)	10,000
Masonry arch culverts	7,000
Bridging	217,000
800 lineal feet tunnel, at $60	48,000
18,000 square yards slope paving, at 70 cents	12,600
3,000 lineal feet protection piling, at $2.50	7,500
Road crossings and cattle guards	435
14 miles fencing, at $500	7,000
15 miles telegraph line, at $300	4,500
3 stations and freight-houses	6,500
1 coal station	500
1 water tank	600
Draining slide section	2,000
Temporary trestling, removing bridges	6,000
Total	$632,765
Credit	82,765
Final total	$550,000

CREDIT.

1,700 tons rails, at $20	$34,000
27,000 ties, at 30 cents	8,100
3 spans Portage bridge, 375,000 pounds, at 3.5 cents	20,125
1 Wiscoy Creek bridge, 51,000 pounds, at 3 cents	1,530
1 Cold Creek bridge, 67,000 pounds, at 3 cents	2,010
1,000 cubic yards masonry in Portage bridge, at $2	2,000

5,000 cubic yards masonry, in lock and other structures, at $1	$5,000
Stations and buildings	2,000
160 acres right of way, at $50	8,000
Total	$82,765

COMPARISON OF THE PRESENT LOCATION WITH THE PROPOSED NEW LOCATION.

The present location of the Western New York and Pennsylvania railway along the line of the old Genesee Valley canal can not be considered an especially desirable railway location. It certainly is not as good a railway line from an engineering point of view as could be made through this valley. The exigency of following the canal right of way was to the disadvantage of the original location. The new location, on the other hand, is at some disadvantage on account of taking up the present line at points outside of the reservoir which would not be selected as points of departure if it were a question of relocating independent of the reservoir.

The following statements exhibit the relative value of the present line in comparison with the new line:

Total length of the present line from Portage bluff to near Houghton station is 16.74 miles; the length of the proposed new line between the same points is 15.4 miles, whence we have a reduction in length by the new line of 1.34 miles.

The total length of curves on the present line is 5.96 miles; on the proposed line, 6.68 miles, whence we have a greater length of curves on the new line of 0.72 miles. Some of the excess curvature may be done away with on revision of line.

The total length of tangent on the present line is 10.78 miles; on the proposed new line it is 8.72 miles; giving a difference of 2.06 miles in favor of the present line. The curvature of the present line is 35.5 per cent. of the whole; of the proposed new line it is 43.4 of the whole.

The tangents of the present line are 64.5 of the whole; of the proposed new line, 56.6 per cent. of the whole.

United States Weather Bureau.

	7.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	89	1.58	2.00	2.57	2.97	3.85	1.77	3.84	3.50	3.77	2.85
January	34	1.87	3.33	4.83	3.75	2.73	1.50	3.27	3.12	3.38	3.16
February	75	0.85	2 41	3.59	4.17	2.77	3.81	3.41	2.50	5.37	2.83
March	94	2.34	1.78	2.99	4.44	2.44	1.81	1.84	1.56	6.32	3.00
April	51	1.22	2.84	2.17	1.89	1.12	3.97	2.03	2.04	1 09	2 43
May	17	1.79	2.36	6.00	1.12	4.84	5.69	6.87	3.44	1.64	3.04
Total	60	9.65	14.72	22.15	18.34	17.75	18.05	21.26	16.16	21.57	17.31
June	51	4.69	5.36	2.66	1.56	6 68	0.94	3.43	1.56	2.80	3.20
July	90	1.12	3.08	1.62	3.62	3.21	2.81	2.92	1.88	4.75	3.04
August	59	3.61	1.12	2.31	3.01	3 52	5.61	0.70	3.40	2.71	3.06
Total	00	9.42	9.56	6.59	8.19	13.41	9.36	7.05	6.84	10.26	9.30
Septembe	90	2.19	2.21	5.13	1.41	1.55	2.26	2.63	2.38	3.50	2.39
October	31	3.22	4.02	4.77	2.36	0.78	1.83	2.86	1.38	0.58	2.90
Novembe	80	2.86	4.62	4.05	2.46	3.61	1.93	1.65	3.39	2.49	2.86
Total	01	8.27	10.85	13.95	6.23	5.94	6.02	7.14	7.15	6.57	8.15
Yearl	61	27 34	35.13	42.69	32.76	37.10	38.43	35.45	30.15	38.40	34.76

The total curvature of the present line is 1,658°; of the proposed new line, 1,684°; difference of the two, 26°. The maximum grade going south of the present line is 86.5* feet per mile; on the proposed new line it is 66 feet per mile. The maximum grade going north on the present line is 33.8 feet per mile; of the proposed new line it is 33 feet per mile.

The present line has a 11° 48′ curve at Portage station; also several 9° and 10° curves between Portage station and Portage bluff; a 10° curve just south of Portage bluff and several 8° curves further south; also a maximum curve of 11° 54′ at Portage bluff.

The proposed new line reduces the 11° 54′ curve at Portage bluff to 11°, and has no other curves exceeding 8°. With the exception of two 8° curves, the curvature of the proposed new line does not exceed 6°.

The foregoing estimates provide for the construction of the proposed new line in the most substantial manner, with first-class bridging, masonry and arch and cast iron pipe culverts. The 800 feet of tunnel just west of Wiscoy will be through compact clay lined with brick.

As shown by the estimates, there are certain materials in the road as it now stands whch may be credited to the new work, to the amount of $82,765. The plans of the new work include the utilizing of this material at the values affixed.

Taking into account the material reduction in length of line, as well as the great reduction in the degree of curvature, it is believed that the proposed new line is a much better line to operate than the present one.

SOURCE OF THE MATERIALS FOR THE PORTAGE DAM.

As already stated on page 670, the estimated cost of the dam at Portage is much less than at Mount Morris because of less depth of foundation, narrower river valley, as well as the presence of material on the ground for making a great portion of the work. At Mount Morris, with the exception of sand, material must all be brought from a distance, the greater portion of it to be taken from Portage, in the immediate vicinity of the proposed Portage site.

* This is, however, near Oakland station, outside the limits of the proposed change.

The transportation of the considerable amount of material required at Mount Morris becomes a very important item of the total cost at that place. It was in this view that the item in the Supply Bill provided for further consideration of transportation questions. With the dam located at Portage, however, transportation questions are not leading ones, the material to be transported from a distance consisting chiefly of about 25,000 cubic yards of sandstone to be used in the face of the dam. As to sand, the indications are that it can be obtained on the line of the Erie Railway within a very short distance of the proposed work.*

As to the method of constructing the dam, it is proposed to make the exterior faces of sandstone, to be brought either from the vicinity of Olean or from Klipnockie quarry, in the town of Almond, Allegany county, or, failing in obtaining stone of the proper quality and in sufficient quantity from either of these points, the stone may be obtained from extensive quarries on the line of the Western New York and Pennsylvania Railway near Oil City, Pennsylvania, to which reference was made in the report on Genesee storage, dated December 15, 1893.†

The estimated cost of stone from Oil City is given in the 1893 report.

QUALITY OF THE CHEMUNG SANDSTONES.

As stated in the report of Mr. Clarke, the Olean stone as well as the Klipnockie are geologically in the Chemung group, and, while the stone of this formation have not yet been extensively used for building purposes, it is believed that stone of the proper quality may be readily obtained from this formation within reasonable distance of Portage. So far as can be learned, no analyses of the Chemung sandstones from the vicinity of Olean have ever been made. The stone there are, however, homogenous, medium grade stone with every indication of qualities of durability.

*The writer does not wish to be understood as absolutely deciding this question at this time. Some further explorations of the sand beds on the line of the Erie Railway are needed in order to fully develop their capacity as well as the quality of the material to be obtained. In any case, the sand can be brought from points on the line of the Western New York and Pennsylvania Railway at small expense.

†Annual report State Engineer and Surveyor for the fiscal year ending Sept. 30, 1893, pp. 422-25.

ive.

	887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	22 5	29.1	30.1	36.6	24.0	36.2	26.2	27.1	32.2	32.8	28.6
January	22.6	17.8	29.5	32.7	27.1	23.2	17.0	29.7	23.0	22.8	24.0
February	24.9	24.2	18.1	30.5	29.6	27.6	22.1	22.2	18.1	24.6	24.1
March	20.8	24.7	32.8	29.1	30.4	27.6	31.0	39.0	26.9	25.4	29.6
April	41.9	40.5	44.5	44.6	47.2	43.4	41.6	46.4	44.8	41.6	43.2
May	62 6	54.1	57.8	52.8	64.0	54.3	55.0	55.8	59.6	63.2	57.0
Mean	32.5	31.7	35.4	37.7	37.0	35.4	32.1	36.7	34.1	35.1	34.4
June	65.5	66.6	63.2	67.8	67.0	67.8	70.0	68.0	70.7	66.4	66.5
July	74.2	67.7	70.6	70.0	67.0	70.4	69 6	71.0	68.4	71.5	70.2
August	66 4	67.2	66.3	66.2	67.8	68.5	68.0	66.2	67.4	69.7	68.1
Mean	68.7	67.2	66.7	68.0	67.3	68.9	69.2	68.4	68.8	69.2	68.3
September	58.7	57.2	61.4	59.3	64.4	61.0	57.4	63.2	65.2	59.8	61.8
October	46.4	43 6	43.2	49.2	49.8	48.4	50.6	51.2	44.9	47.2	49.2
November	37.6	39.4	40.0	38.6	38.9	35.8	37.6	34.8	40.1	42.5	37.3
Mean	47.6	46.7	48.2	49.0	51.0	48.4	48.5	49.7	50.1	49.8	49.4
Yearly mean	45.3	44.3	46.5	48.1	48.1	47.0	45.5	47.9	46.8	47.3	46.6

The stone from the Klipnockie quarries, as analyzed by E. P. Harris, of Amherst College, Massachusetts, in March, 1892, shows the following composition:

	Per cent.
Silica	93.33
Alumina	3.30
Ferric oxide	0.33
Lime	1.19
Magnesia	0.20
Carbonic acid	0.40
Water	1.20
	99.92

The Klipnockie stone have also been tested, in February, 1896, by Dr. C. F. Chandler, of Columbia University, for crushing strength, with the following results:

With a two-inch cube set on edge, the crushing load per square inch was 18,579 pounds.

With a cube of the same size set on the beds, the crushing load per square inch was 18,995 pounds.

Dr. Chandler also reports that this stone, when tested by the fire test, resisted low red heat very well, no cracking being apparent. When suddenly cooled with cold water the specimen did not crack, but the cementing silicates softened, the stone weakening, and in some places crumbling.

The following gives the record of a breaking test of six cubes of 6 inches from the Klipnockie quarries as just made from blocks forwarded by the owner of the quarries to the U. S. Arsenal at Watertown, Massachusetts, at the author's request:

Number of test.	DIMENSIONS.			Sectional area.	FIRST CRACK.		ULT. STRENGTH.	
	Height.	Compressed surface.			Total.	Per sq. inch.	Total.	Per sq. inch.
	Inches.	Inches.	Inches	Sq. inches.	Lbs.	Lbs.	Lbs.	Lbs.
9861	6.15	6.05	6.03	36.48	299,000	8,196	404,600	11,091
9862	6.14	6.03	6.02	36.30	299,500	8,251	445,800	12,281
9863	6.06	6.05	6.05	36.60	198,000	5,410	443,700	12,123
9864	6.10	6.05	6.08	36.78	391,000	10,604	491,200	13,355
9865	6.13	6.08	6.03	36.66	593,900	16,200	593,900	16,200
9866	6.16	6.03	6.00	36.18	204,000	5,638	426,000	11,774

COST OF TRANSPORTATION.

The Western New York and Pennsylvania Railway offer to transport stone from Olean to Portage at the rate of 50 cents per net ton. From Oil City their rate is the same as given three years ago, 80 cents per net ton.

Stone from Klipnockie quarry would require transportation over the Central New York and Western Railroad Company's line from some point near either Birdsell or Canaserga to Nunda Junction, and from there over the Western New York and Pennsylvania Railway to Portage. The Central New York and Western Railway Company offer to make a rate of 60 cents per net ton from the quarries to Portage.

It is believed that the stone can be loaded on cars at either Olean or Klipnockie for not exceeding $1.50 to $2 per cubic yard.

Taking the foregoing figures as to cost of transportation and loading on cars as the basis, it is believed that the sandstone facing of the dam can be made of fair sized blocks at a cost not exceeding $7.50 per cubic yard.

QUALITY OF STONE REQUIRED.

As regards the quality of stone to be used in the facing of the dam, it should be homogenous, with no more tendency to split in one direction than in another. Many of the sandstones of the Chemung formation do not answer this requirement, but show, in several of the quarries examined, so many lines of vertical parting as to immediately indicate their inapplicability for work of this character. Some of the stones in the vicinity of Olean, however, are apparently free from this objection, as well as a portion of the Klipnockie quarry in the town of Almond. The Olean stone may be seen in water tables, door and window sills and caps, as used in the city of Olean for the last forty or fifty years. The Klipnockie stone was also examined at a private residence at Angelica, where a stone pier has taken the drip of a conductor pipe for fourteen years and still shows the chisel marks plainly, thus indicating the absence of any tendency to chip by freezing and thawing when exposed to moisture. The Olean stone also shows favorably

in this particular. Both of these stones are, generally speaking, rather hard to work, a practical difficulty, adding considerably to the expense, even though found, on final examination, unobjectionable in all other particulars. In any case, if it should be finally concluded that the stone of the Chemung group are not available for this work, the fine sandstones in the vicinity of Oil City can be obtained at small additional expense. Their use, however, involves the objection of taking the stone for a State work of considerable magnitude from outside the State.

As shown by the estimates, it is proposed to use a small amount of granite in the work, which will be brought from the vicinity of Forestport, about 25 miles north of Utica.

The general design of the dam, as proposed, is so clearly shown by Plates D to J, inclusive, as to make extended description unnecessary. The following is the detailed estimate of cost of the dam:

DETAILED ESTIMATE OF COST OF DAM.

5 acres clearing and grubbing, at \$60	\$300
38,000 cubic yards of foundation excavation (rock) at 75 cents	28,500
86,000 cubic yards stripping (earth and loose rock excavation), at 25 cents	21,500
132,500 cubic yards rock excavation for spillways, etc., at 60 cents	79,500
22,000 square feet channeling, at 15 cents	3,300
2,500 lineal feet drill hole for grouting, at 10 cents	250
2,000 barrels of extra fine ground Portland cement, grouted in foundations, at \$3.50	7,000
100,000 feet B. M. of temporary timber work in coffer dam, at \$25	25,000
5,000 cubic yards puddle in coffer dam, at 50 cents	2,500
600 cubic yards granite masonry, at \$18	10,800
25,000 cubic yards sandstone rubble masonry in face of dam, at \$7.50	187,500
114,000 cubic yards backing, at \$4	456,000
7,000 cubic yards retaining wall, at \$5	35,000

4,000 cubic yards spillway wall, at $9	$36,000
670 cubic yards rubble arch masonry, at $8	5,360
1,000 cubic yards gate-house, tower and railing masonry, at $12	12,000
2,500 cubic yards brick masonry, at $10	25,000
8,200 cubic yards concrete, at $4	32,800
Roofing gate-house and towers, and doors, windows and interior finish of same	4,500
Iron railings, stairways, etc	4,000
260 net ton (48-inch) cast-iron pipe, at $20	5,200
33 net ton special pipe castings, at $40	1,320
4 (48-inch) stop gates, at $800	3,200
2 (16-inch) stop gates, at $100	200
Pipe laying	1,000
2 large slide gates, with operating mechanism, at $1,200	2,400
2 (12-inch)turbine water-wheels, with shafting, etc	1,000
1,700 square yards asphalt roadway across bridge, at 80 cents	1,360
20,000 square feet face work on rubble masonry, at 30 cents	6,000
10,000 square feet fine hammered face dressing, at 50 cents	5,000
10,000 square feet rough-jointed face dressing, at 25 cents	2,500
Electric light plant, with lamps, wiring, etc	7,000
Air compressor, receiver and connections	4,610
Weir dam and gaging appliances	5,000
Total	$1,000,000

In regard to the foregoing estimate, it may be remarked that no item for bailing and draining has been included. As may be seen by referring to the plans, Plates D to J, it is proposed to make four large tunnels directly through the dam, each 14 feet in diameter, through which the ordinary flow and medium floods may be discharged without difficulty. All that is required will be a cheaply con-

TABLE N

The average mean temperature of the upper Genesee river drainage area in

(Rainfall, runoff and evaporation

MONTH.	1893. Mean temperature.	Rainfall.	Runoff.	Evaporation.	Mean temperature.
December	22°.2	1.23	....	....	26°.[illegible]
January	14°.5	2.68	....	....	28°.[illegible]
February	20°.9	4.49	....	....	20°.[illegible]
March	28°.9	2.85	....	....	37°.[illegible]
April	41°.0	3.65	....	....	42°.1
May	53°.0	5.75	....	....	54°.[illegible]
Total and mean	30°.1	20.65	....	....	35°.[illegible]
June	65°.8	2.11	....	....	64°.[illegible]
July	66°.9	2.27	....	....	67°.[illegible]
August	65°.6	5.17	....	....	63°.[illegible]
Total and mean	66°.1	9.55	....	....	65°.[illegible]
September	56°.1	3.74	0.33	....	61°.[illegible]
October	48°.7	2.95	0 38	....	49°.[illegible]
November	35°.3	2.41	0.54	....	3[illegible]
Total and mean	46°.7	9.10	1.25	7.85	47°.[illegible]
Yearly total and mean	43°.2	39.30	....	....	45°.[illegible]

No. 25.

comparison with the runoff of the stream, from 1893 *to* 1896, *inclusive.*

in inches on the watershed.)

1894.			1895.				1896.			
Rainfall.	Runoff.	Evaporation.	Mean temperature.	Rainfall.	Runoff.	Evaporation.	Mean temperature.	Rainfall.	Runoff.	Evaporation.
3.39	2.34	....	29°.0	2.47	0.61	....	30°.1	3.80	1.82	....
3.91	1.40	....	19°.1	3.26	0.66	....	22°.4	2.29	0.47	....
2 93	0.86	....	14°.5	1.22	0.22	....	22°.9	3.56	0.91	....
1.62	3.31	....	28°.0	1.72	1.94	....	22°.7	4.00	3.00	....
7.22	3.39	....	44°.2	2.10	2.01	....	47°.7	1.62	3.38	....
8.64	4.43	....	57°.8	2.43	0.19	....	60°.7	2.57	0.17	....
27.71	15.73	11.98	32°.1	13.20	5.63	7.57	34°.4	17.84	9.25	8.59
2 54	1.10	....	67°.5	4.57	0.13	....	62°.1	3.52	0.39	....
3.70	0 14	....	64°.1	2.57	0.11	....	67°.3	5.90	0.24	....
1.74	0.22	....	66°.5	3.99	0.12	....	65°.0	1.86	0.20	....
7.95	1.46	6.49	66°.0	11 13	0.36	10.77	64°.8	11.28	0.83	10.45
6 97	0 93	....	61°.7	1.96	0.10	....	57°.5	5.22	0.16	....
3.50	0.44	....	41°.8	1.30	0.11	....	43°.6	4 08	1.74	....
1.66	0 82	....	38°.0	3 41	0.47	....	41°.6	3.26	0.82	....
12.13	2.19	9.94	47°.2	6.67	0.68	5.99	47°.6	12 56	2.72	9.84
47.79	19.38	28.41	44°.3	31.00	6.67	24 33	45°.3	41.68	12.80	28.88

structed coffer dam to divert the river from one side to the other during the excavating and placing of the foundations. Diamond drill borings, made during the summer of 1896, indicate that the foundation rock is of such close texture as to render any considerable inflow of water into the shallow foundation excavation improbable, hence, only a comparatively small pumping plant will be required, the cost of which may be included in the whole work. After the entire structure has been raised a short distance above the level of the discharge tunnels, no further precautions in the way of bailing and drainage will be necessary, except that the contractor will be required to assume the responsibility of extreme floods going over the face of the work. To guard against serious damage from such contingency, the work must be so prosecuted as to be quickly cleared of machinery and appliances in case of flood.

WORK AT NIGHT BY ELECTRIC LIGHT.

In order to complete the work in the shortest possible space of time, it is also proposed to provide in the specifications for the setting up of an electric light plant at the Portage falls, a short distance below, in order to furnish electric light for working at night. By this arrangement workmen will be always on hand during the working season, and the necessary precautions may be instantly taken at the first indication of flood.

It is also proposed, by the use of Portland cements, to prosecute the work much later in the fall, into moderate freezing weather, than would be possible were natural cements to be used. By the application of these several innovations, on ordinary work, it is believed that the time of construction may be reduced to about two years.

ARCHITECTURAL FEATURES OF THE DAM.

In view of the fact that the Portage falls and gorge are already one of the famous tourist resorts of the State of New York, it is considered desirable to construct the dam and works connected therewith with reference to some little architectural adornment.

The elevations and sections, Plates E to J, show clearly what is proposed in this line. By the use of the best layers of the Portage stone, in sawed blocks, it is possible to construct the ornamental towers and gate-houses at only small expense. In any case, the discharge tunnels are a necessary part of the design as affording the only practicable method of controlling the river during the construction period, while they also afford convenient passages for permanently discharging water to the river after the dam is completed, as shown by the plans. The buttressing over the discharge tunnel becomes necessary in order to compensate for the considerable decrease in section due to the subtraction of the volume of the tunnels themselves, as well as for the passages through the interior of the dam, which have been included by way of affording convenient access from the gate-house to the lower regulating gates.

In order to operate the upper regulating slide gates, the design includes a small air compressing plant. A small electric lighting plant is also included, in order to light the passages, as well as to light the bridge over the top of the dam itself, which has been provided to take the place of the present bridge over the river at Portageville.

The estimates also include the cost of a measuring weir and gaging appliances to be built across the river channel just below the upper falls, in order to keep a record of the actual discharge from day to day. This weir will be substantially constructed of masonry, and will be, in every particular, a permanent appendage of the proposed works.

BRIDGES OVER RESERVOIRS.

In addition to land damages, changing the Western New York and Pennsylvania Railway, and the cost of the dam itself, the estimates also include the cost of two bridges over the reservoir, one of them to be located just above Rossburg and the other a short distance above Fillmore. The following is the estimated cost of the necessary highway bridging:

ESTIMATED COST HIGHWAY BRIDGES OVER RESERVOIR.

80,500 cubic yards embankment, at 16 cents	$12,880
15,500 square yards slope paving, at 70 cents	10,850
1,750 lineal feet highway bridging, at $20	35,000
800 lineal feet highway bridging, at $25	20,000
Amount	$78,730

35,000 cubic yards embankment, at 16 cents	$5,600
9,000 square yards slope paving, at 70 cents	6,300
370 lineal feet highway bridging, at $25	9,250
Amount	$21,150
Amount as above	78,730
Total cost of two bridges	$99,880

In order to make even figures, the foregoing total of $99,880 may be taken at $100,000.

As further main items of the estimate, we include the clearing of the reservoir, the wagon road entirely around the reservoir and the moving of the cemeteries. With these items we have the following:

SUMMATION OF THE ESTIMATES.

Land damages for reservoir	$650,000
Changing location of railway	550,000
Dam	1,000,000
Wagon road bridges over reservoir	100,000
Clearing reservoir	30,000
Wagon road around reservoir	30,000
Moving cemeteries	15,000
Contingencies, engineering, and law expenses, about 10 per cent	225,000
	$2,600,000

COST OF RESERVOIR AT PORTAGE, STORING 7,500,000,000 CUBIC FEET.

Referring to Table No. 26, it is learned that in order to make a storage at Portage of about 7,500,000,000 cubic feet (the approximate equivalent of the storage to be made with a dam 130 feet in height at Mount Morris), that a dam 90 feet in height will be required. The estimate for such a reservoir stands as follows:

Land damages	$450,000
Railway	400,000
Dam	670,000
Wagon road bridges over reservoir	70,000
Clearing	20,000
Wagon road	20,000
Moving cemeteries	5,000
Contingency item	165,000
Total	$1,800,000

As shown further on, the State will require, when the present canal enlargement is completed, to take regularly from the Genesee river during the season of canal navigation, a considerable quantity of water. In order to provide for such demands of the canal, it is considered that a storage of 2,500,000,000 cubic feet should be made on the Genesee river for canal purposes alone. Referring to Table No. 26, it is learned that a storage of 2,500,000,000 cubic feet will require a dam at Portage 61 feet in height. The general estimate for such a reservoir takes the following form:

ESTIMATED COST OF DAM STORING 2,500,000,000 CUBIC FEET.

Land damages	$350,000
Railway	325,000
Dam	500,000
Bridge over reservoir	10,000
Clearing	15,000

Wagon road	$16,000
Moving cemetery	3,000
Contingency item	131,000
Total	$1,350,000

In discussing the Genesee storage project in former years it has been assumed, in view of the equities of the case, that even though the State did not construct the entire reservoir, still it might justly be asked to construct a dam up to the height actually required for State purposes, with such a width of base as would permit of building the same to the full height required for furnishing storage for power purposes over and above the State requirements.

The following is the estimate for a dam 61 feet in height, but built with such width of base as to permit of a final extension to the full height of 118 feet:

ESTIMATED COST OF A DAM AT PORTAGE, 61 FEET IN HEIGHT, BUT BUILT WITH SUCH WIDTH OF BASE AS TO PERMIT OF A FINAL EXTENSION TO THE HEIGHT OF 118 FEET.

Land damages	$350,000
Railway*	550,000
Dam	555,000
Bridges over reservoir	40,000
Clearing	15,000
Wagon road*	30,000
Moving cemeteries	3,000
Contingency item	157,000
Total	$1,700,000

*Under this plan it is considered desirable to complete the railway and wagon road as part of the original construction.

DEVELOPED WATER POWER OF THE GENESEE RIVER.

Referring to Table No. 31, we find therein a statement of developed water power of the Genesee river from Mount Morris to Rochester, inclusive, as it exists in 1896. Inasmuch as there is no developed water power between Mount Morris and the site of the proposed dam at Portage, Table No. 31, therefore, includes a statement of all developed water power on the river below the Portage reservoir. Examining this table, we see that the total power at Mount Morris is, basing the figures on the manufacturer's rating, 570 horse power. At Geneseo and York there are also small powers of 40 and 30 net horse power respectively. At Rochester, taking the several raceways and powers in order going down stream we have the following: For the Rochester, Carrol and Fitzhugh race the total power is 1,070 net horse power; for the Johnson and Seymour race, 1,076 net horse power; for Brown's race, 8,250 net horse power; for the Rochester Power Company's race, 2,395 net horse power; for the middle falls, 2,215 horse power; for the lower falls, 3,532 horse power, giving a total of the present power at Rochester of 18,538 horse power. This, it will be understood, is as per the manufacturer's rating of amount of water used on the wheels and as to the power developed. From Column 12 of Table No. 31 we also learn that the stated quantity of water, when computed on the basis of 75 per cent. efficiency, will yield 16,683 horse power, instead of 18,538, as per manufacturer's rating. The total quantity of power in use in Rochester in 1882, was, as per United States Census report, 6,442 net horse power. The increase, therefore, in fourteen years, has been about 12,000 horse power, or 186 per cent.*

Table No. 31 also indicates the total power in use from Mount Morris to Rochester, inclusive, as 19,178 net horse power, manufacturer's rating, or 17,248 horse power when computed on 75 per cent. efficiency. The total used in 1882 was 6,882 net horse power, giving a total increase for the whole river, on the basis of the manufacturer's rating, of about 12,300 horse power.

*For statement of water power in use at Rochester in 1882, see Statistics of Power and Machinery Employed in Manufactures. By Professor W. P. Trowbridge. Reports on the Water Power of the United States. Part I. Vol. XVI of the Tenth Census, pp. 468-470.

REGULATION EFFECTED BY THE PROPOSED STORAGE.

Table No. 27 shows the regulation of the Genesee river effected by a storage of 7,500,000,000 cubic feet for the period from July 1894, to November, 1896, inclusive, together with the amount of water required for canal purposes, as well as the ratio of that amount to the natural flow of the stream. This table is computed on the basis of at least 300 cubic feet per second always flowing at Portage, and at least 600 cubic feet per second at Rochester over and above the amount required for the use of the Erie canal at that place.

Table No. 28 shows the state of the Portage reservoir from month to month from June, 1894, to November, 1896, with at least 300 cubic feet per second always flowing at Portage, and at least 600 cubic feet per second at Rochester, over and above the amount required for the canal at that place.

Tables Nos. 29 and 30 are similar exhibits of the regulation of the river and the state of the reservoir for the same period, from June, 1894, to November, 1896, inclusive, with a storage of 15,000,000,000 cubic feet, and at least 457 cubic feet per second always flowing out at Portage, and at least 1,000 cubic feet per second at Rochester over and above the amount required for the Erie canal at that place.

By way of further explaining Tables Nos. 27-30, inclusive, we may remark that the drainage area of the Genesee river at Mount Morris is taken at 1,060 square miles. In addition to the runoff from this area, the river receives each summer the storage of Cuba reservoir, amounting to 400,000,000 cubic feet. The Cuba reservoir is naturally tributary to the Allegany river, and the ordinary overflow goes to that stream. The drainage of that portion of the Oil Creek area tributary to the Cuba reservoir is 28 square miles, of which we may consider 10 square miles as the equivalent area from which the water goes to the Genesee river. This gives a total tributary area, during the period covered by the Mount Morris gagings, of 1,070 square miles at Mount Morris and 1,000 square miles at Portage. Hence, we learn that the area controlled by the proposed reservoir at Portage is only 70 square

TABLE No. 26.

Giving the area flowed and volume stored for successive elevations of the water surface of the proposed Portage reservoir, together with the inches in depth on the tributary watershed for various heights.

Elevation of water surface above sea level.	Area of water surface in square miles.	Total volume of water in reservoir, in cubic feet.	Inches on watershed.	Elevation of water surface above sea level.	Area of water surface in square miles.	Total volume of water in reservoir, in cubic feet.	Inches on watershed.
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
1100.0	0.2320	101,400,000	0.044	1128.5	2.5071	1,205,213,000	....
1100.5	0-2621	113,014,000	....	1129.0	2.5701	1,242,795 000	....
1101.0	0.2922	124,637,000	....	1129.5	2 6331	1,280,377,000	....
1101.5	0.3223	136,260 000	....	1130 0	2.6692	1,318,000,000	0.567
1102.0	0.3524	147,883,000	....	1130.5	2.7592	1,355,541,000	....
1102.5	0.3825	159,507,000	....	1131.0	2.8222	1,393,123,000	....
1103.0	0.4126	171,129,000	....	1131.5	2.8852	1,430,705,000	....
1103.5	0.4427	182,800,000	....	1132.0	2.9483	1,468,287,000	....
1104.0	0.4728	194,375,000	....	1132.5	3.0113	1,505,869,000	....
1104.5	0.5029	205,998,000	....	1133.0	3.0743	1,543,451,000	....
1105.0	0.5330	217,623,000	0.094	1133.5	3.1373	1,581,033,000	....
1105.5	0.5631	229,246,000	....	1134.0	3.2004	1,618,615,000	....
1106.0	0.5932	240,869,000	....	1134.5	3.2634	1,656,197,000	....
1106.5	0.6233	252,492,000	....	1135.0	3.3264	1,694,000,000	0.729
1107.0	0.6534	264,115,000	....	1135.5	3.3894	1,731,361,000	....
1107.5	0.6835	275,739,000	....	1136.0	3.4525	1,768,943,000	....
1108.0	0.7136	287,362,000	....	1136.5	3.5155	1,806,525,000	....
1108.5	0 7437	298,985,000	....	1137.0	3.5785	1,842,107,000	....
1109.0	0.7738	310,608,000	....	1137.5	3.6415	1,879 689,000	....
1109.5	0.8039	322,231,000	....	1138.0	3.7046	1,917,271,000	....
1110 0	0.8340	333,900,000	0.143	1138.5	3.7676	1,954,853,000	....
1110.5	0.8641	345,477,000	....	1139.0	3.8306	1,992,435,000	....
1111.0	0.8942	357,100,000	....	1139.5	3.8936	2,030,017,000	....
1111.5	0.9243	368,723,000	....	1140.0	3.9566	2,070,000,000	0.891
1112.0	0·9544	380,346,000	....	1140.5	4.0135	2,140,617 000	....
1112.5	0.9845	391,970,000	....	1141.0	4 0704	2,211,629,000	....
1113.0	1.0146	403,603,000	....	1141.5	4.1273	2,282,641,000	....
1113.5	1.0447	415,226,000	....	1142.0	4.1842	2,353,653,000	....
1114.0	1.0748	426,849,000	....	1142 5	4.2411	2,424,665,000	....
1114.5	1.1049	438,472,000	....	1143.0	4.2980	2,495,677,000	....
1115.0	1.1350	450,100,000	0.194	1143.5	4.3549	2,566,689,000	....
1115.5	1.1651	461,710,000	....	1144.0	4.4118	2,637,701,000	....
1116.0	1.1952	473,333,000	....	1144.5	4.4687	2,708,713,000	....
1116.5	1.2253	484,956,000	....	1145.0	4.5255	2,780,000,000	1.196
1117.0	1.2554	496,579,000	....	1145.5	4.5824	2,850,737,000	....
1117 5	1.2855	508,202,000	....	1146 0	4.6393	2,921,749,000	....
1118 0	1.3156	519,825,000	....	1146.5	4.6962	2,992,761,000	....
1118 5	.3457	531,448,000	....	1147.0	4.7531	3,063,773,000	....
1119.0	1.3758	542,071,000	....	1147.5	4 8100	3,134,785,000	....
1119.5	1.4059	553,694,000	....	1148.0	4.8669	3,205,797,000	....
1120.0	1.4357	566,300,000	0.244	1148.5	4.9238	3,276,809,000	....
1120.5	1.4987	603,901,000	....	1149 0	4.9807	3,347,821,000	....
1121.0	1.5617	641,483,000	....	1149.5	5.0376	3,418,833,000	....
1121.5	1.6247	679 065,000	....	1150.0	5.0944	3,490,000,000	1.502
1122 0	1.6878	716,647,000	....	1150.5	5.1513	3,560,854,000	....
1122.5	1.7508	754,229,000	....	1151.0	5.2082	3,631,866,000	....
1123.0	1.8138	791,811,000	....	1151.5	5.2651	3,702,878,000	....
1123.5	1.8768	829,393,000	....	1152.0	5.3220	3,773,890,000	....
1124.0	1.9399	866,975,000	....	1152.5	5.3789	3,844,902,000	....
1124.5	2.0029	904,557,000	....	1153.0	5 4358	3,915,914,000	....
1125.0	2.0659	942,100,000	0.406	1153.5	5.4929	3,986,926,000	....
1125.5	2.1289	979,721,000	....	1154.0	5.5496	4,057,938,000	....
1126.0	2.1920	1,017,303,000	....	1154.5	5.6065	4,128,950,000	....
1126.5	2 2550	1,054,885,000	....	1155.0	5.6633	4,200 000,000	1.806
1127.0	2.3180	1,092,467,000	....	1155.5	5.7202	4,270,974,000	....
1127.5	2.3810	1,130,049,000	....	1156.0	5.7771	4,341,986,000	....
1128.0	2.4441	1,167,631,000	....	1156.5	5.8340	4,412,998,000	....

TABLE No. 26 — (*Concluded*).

Elevation of water surface above sea level.	Area of water surface in square miles.	Total volume of water in reservoir, in cubic feet.	Inches on watershed.	Elevation of water surface above sea level.	Area of water surface in square miles	Total volume of water in reservoir, in cubic feet.	Inches on watershed.
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
1157.0	5.8909	4,484,010,000	....	1184.0	9.2730	10,102,565,000	....
1157.5	5 9478	4,555,022,000	....	1184.5	9.3545	10,234,098,000	....
1158.0	6.0047	4,626,034,000	....	1185.0	9 4362	10.366 000,000	4 462
1158.5	6.0616	4,697,046,000	....	1185.5	9.5177	10,497.164.000	....
1159 0	6.1185	4,768,058,000	....	1186.0	9.5993	10.628,697,000	....
1159.5	6.1754	4,839.070,000	....	1186.5	9.6808	10,760,230,000	....
1160.0	6.2322	4,910,000,000	2.113	1187.0	9.7624	10,891,763,000	....
1160.5	6.2919	5.013,597,000	....	1187.5	9.8439	11,023.296,000	....
1161.0	6.3516	5,117,115,000	....	1188.0	9.9255	11,154,829.000	....
1161.5	6.4113	5,220,633,000	....	1188.5	10.0070	11,286,462.000	....
1162.0	6 4710	5,324,151,000	....	1189 0	10 0886	11,417,995,000	....
1162.5	6.5307	5,427,669,000	....	1189.5	10.1701	11,549,528,000	....
1163.0	6.5904	5,531,187,000	....	1190.0	10.2518	11,681,500,000	5.016
1163.5	6.6501	5,634.705,000	....	1190.5	10 3567	11.838,984,000	....
1164.0	6.7098	5,738,223.000	....	1191.0	10.4616	11,996,506,000	....
1164.5	6.7695	5.841,741.000	....	1191.5	10.5665	12 154,028,000	....
1165.0	6.8293	5.945,000,000	2.559	1192.0	10.6714	12,311 550,000	....
1165.5	6 8890	6,048,777,000	....	1192 5	10.7763	12,469.072.000	....
1166.0	6.9487	6,152.295,000	....	1193.0	10.8811	12,626,594,000	....
1166.5	7.0084	6,255,813,000	....	1193 5	10.9860	12,784.116,000	....
1167.0	7.0681	6,359,331.000	....	1194.0	11.0909	12,941,638,000	....
1167.5	7.1278	6,462,849.000	....	1194.5	11.1958	13.099.160,000	....
1168.0	7.1875	6,566 367,000	....	1195.0	11.3007	13,257,000,000	5.710
1168.5	7.2472	6,669,885,000	....	1195.5	11.4056	13 431.000 000	....
1169.0	7.3069	6,773,403,000	....	1196 0	11 5105	13 605,000.000	....
1169.5	7.3666	6,876,921,000	....	1196.5	11 6153	13.789,000.000	....
1170.0	7.4264	6,980,000,000	3.004	1197.0	11.7202	13,763,000,000	....
1170.5	7.4861	7,083.958,000	....	1197.5	11.8251	14,137.000.000	....
1171.0	7.5458	7,187,476,000	....	1198.0	11 9300	14,311,000.000	....
1171.5	7.6055	7,190.994,000	....	1198.5	12.0349	14 485,000,000	....
1172.0	7.6652	7,395,000,000	3 182	1199.0	12.1398	14.659,000,000	....
1172.5	7.7249	7,498.000,000	3.228	1199 5	12.2447	14,830,000,000	....
1173.0	7.7846	7.602,000.000	3.271	1200.0	12.3495	15.000,000,000	6 458
1173 5	7.8443	7,705.066.000	....	1200 5	12.4164	15,013.000 000	....
1174 0	7.9040	7,808.584,000	....	1201.0	12.4833	15.195,000,000	....
1174.5	7.9637	7,912,102 000	....	1201.5	12.5502	15,376 000,000	....
1175.0	8.0235	8,016,000 000	3.451	1202 0	12.6171	15,558,000,000	....
1175.5	8.0832	8,119,138,000	....	1202.5	12.6840	15,739,000,000	....
1176.0	8.1429	8,222,656,000	....	1203.0	12.7509	15,921,000,000	....
1176.5	8.2026	8,326,174.000	....	1203.5	12 8178	16,102 000.000	....
1177.0	8.2623	8,429,692 000	....	1204.0	12.8847	16 284,000.000	....
1177.5	8.3220	8,533,210,000	....	1204.5	12.9516	16,465.000,000	....
1178.0	8.3817	8,636.728,000	....	1250.0	13.0185	16.647,000,000	....
1178 5	8.4414	8.740,246,000	....	1205.5	13 0854	16.828,000,000	....
1179.0	8.5011	8,843,764,000	....	1206.0	13 1523	17.010,000,000	....
1179.5	8.5608	8,947.282,000	....	1206.5	13.2192	17,191 000,000	....
1180.0	8.6206	9.051,000,000	3.896	1207.0	13.2861	17,372,000,000	....
1180.5	8.7021	9,182.334,009	....	1207.5	13.3530	17,554,000,000	....
1181.0	8.7837	9,313,867,000	....	1208.0	13.4199	17,735,000,000	....
1181.5	8.8652	9,445 400 000	....	1208.5	13.4868	17.917,000,000	....
1182.0	8.9468	9,576,933,000	....	1209.0	13.5537	18,093 000,000	....
1182.5	9.0283	9,708,466,000	....	1209.5	13.6206	18,280,000,000	....
1183.0	9.1099	9,839,999,000	....	1210.0	13.6875	18,461,000,000	....
1183.5	9.1914	9,971,032,000	....				

miles less than the area at Mount Morris. On this basis we have a tributary drainage area at Portage equal to 0.9346 of the area at Mount Morris. As stated at page 380 of the report on Genesee storage of date April 1, 1894, already referred to, the drainage

area of the Genesee river at Rochester may be taken at 2,425 square miles. This figure includes an allowance for the Cuba reservoir. Of the 2,425 square miles, 60 square miles is included in the area of the Hemlock and Canadice lakes, which furnish the domestic water supply of the city of Rochester. As that city grows in the future, the full flow of these lakes will be diverted for the city supply in the year of minimum flow. As regards the computation of the flow of the Genesee river above Rochester, therefore, we ought not to consider the drainage area of these two lakes, the flow from which is delivered into the river through the city sewers mostly below the Genesee falls, where it is neither available for the use of the canal nor for power. Deducting, then, the drainage area of these lakes we have (2,425 — 60) = 2,365 square miles as the available drainage area of the Genesee river at Rochester. With the drainage area at Mount Morris taken at 1,070 square miles we have, then, available area at Rochester 2.21 times the area at Mount Morris.

WATER SUPPLY OF THE ENLARGED CANAL.

A study of the water supply of the enlarged Erie canal, as made during the winter of 1895–96 shows that there will be required in dry years a constant supply from the Genesee river of 80 cubic feet per second during the navigation period. In addition to the constant supply of 80 cubic feet per second, there will also be required at the time of filling the canal, about May 1st, a total of 302,000,000 cubic feet to be furnished in say six days. The balance of the supply for the month of May, at the rate of 80 cubic feet per second, amounts to 172,800,000 cubic feet. Adding the two together, we have a total demand for the month of May of 474,800,000 cubic feet; hence, the mean demand is, for the month of May, 177 cubic feet per second. We have, therefore, a demand for the canal, as shown by Columns 6 of Tables Nos. 27 and 29, of 80 cubic feet per second for every month of the navigation season except May, where the mean demand for the whole month is 177 cubic feet per second.

TABL

Showing the regulation of the Genesee River effecte[d] June, 1894, to November, 1896, inclusive, together and its ratio to the natural flow of the stream; at Portage, and at least 600 cubic feet per secon[d] Rochester.

MONTH.	Proposed minimum flow to be maintained at Rochester—cubic feet per second.	Natural flow at Rochester—cubic feet per second.	Natural flow at Portage—cubic feet per second.
(1)	(2)	(3)	(4)
1894.			
June	680	2,321	981
July	680	292	123
August	680	442	187
September	680	1,963	830
October	680	899	380
November	680	1,729	731
December	600	1,256	531
1895.			
January	600	1,335	565
February	600	495	209
March	600	3,985	1,684
April	600	4,257	1,800
May	777	385	163
June	680	283	120
July	680	232	98
August	680	254	108
September	680	221	93
October	680	230	97
November	680	993	420
December	600	2,710	1,146
1896.			
January	600	964	408
February	600	2,005	848
March	600	6,158	2,604
April	600	7,172	3,033
May	777	347	147
June	680	654	277
July	680	501	211
August	680	416	176
September	680	327	138
October	680	3,667	1,556
November	680	1,728	731

No. 27.

by a storage at Portage of 7,500,000 cubic feet from with the amount of water required for canal purposes with at least 300 cubic feet per second always flowing over and above the amount required for the canal at

… at Portage — cubic feet per second.	Amount to canal — cubic feet per second.	Ratio of amount to canal to actual flow, $= \frac{(6)}{(5)}$	Minimum amount to be added at Portage in order to maintain 600 cubic feet per second at Rochester—cubic feet per second.	Quantity available at Rochester for power purposes —cubic feet per second — (5)+(10)+(11)—(6).	Actual flow from Portage reservoir—cubic feet per second.	Surplus flowing over spillway at Portage reservoir —cubic feet per second.	Column (10) in inches on the watershed.
(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1,340	80	0.035	....	2,205	300	645	0 33
169	80	0 274	511	600	511	....	0.59
255	80	0.181	425	600	425	....	0.49
1,133	80	0.041	....	1,353	300	....	0.33
519	80	0.089	161	739	300	....	0.35
998	80	0.046	....	1,505	300	287	0.33
725	....	....	....	1,241	300	216	0.35
770	....	....	....	1,330	300	260	0.35
286	....	....	314	600	314	....	0.38
2,301	....	....	....	3,867	300	1,266	0.35
2,457	....	....	....	4,197	300	1,440	0.33
222	177	0.460	555	600	555	....	0.64
163	80	0.283	517	600	517	....	0.58
134	80	0.345	546	600	546	....	0.63
146	80	0.315	534	600	534	....	0.61
128	80	0.362	552	600	552	....	0.62
133	80	0.348	547	600	547	....	0.61
573	80	0 081	107	793	300	....	0.33
1,564	....	....	....	1,864	300	....	0.35
556	....	....	44	856	300	....	0.35
1,157	....	....	....	1,457	300	....	0.32
3,554	....	....	....	4,999	300	1,145	0.35
4,139	....	....	....	7,155	800	2,716	0 33
200	177	0.513	577	600	577	....	0.67
377	80	0.122	303	600	303	....	0.34
290	80	0.159	390	600	390	....	0.45
240	80	0.192	440	600	440	....	0.51
189	80	0.245	491	600	491	....	0.57
2,111	80	0.021	....	2,331	300	....	0.35
997	80	0.046	....	1,486	300	269	0.33

REASONS FOR FIXING MINIMUM OUTFLOW FROM RESERVOIRS AT 300 AND 457 CUBIC FEET PER SECOND.

We have already stated that the minimum amount of water to be delivered out of the proposed storage reservoirs is 300 cubic feet per second in the case of a reservoir storing 7,500,000,000 cubic feet, and 457 cubic feet per second in the case of a reservoir storing 15,000,000,000 cubic feet. As to the reason for fixing upon these minimums it may be remarked that in river regulation we ought to so arrange the outflow from the storage reservoir as to make the benefits to all parts of the stream equal. Obviously, the way to do this is to arrange for an outflow proportional to the drainage area. In the present case we have a drainage area at Rochester of 2,365 square miles and one of 1,000 square miles at Portage, or, the area above Rochester is 2.365 times the area above Portage; hence the minimum regulated flow at Rochester may justly be made 2.365 times the assumed minimum flow at Portage. Assuming, on this basis, 1,080 cubic feet per second as the flow below which the stream will never be allowed to fall at Rochester, we have, therefore, for a reservoir storing 15,000,000,000 cubic feet, a corresponding minimum outflow of 457 cubic feet per second; or, for a storage of 7,500,000,000 cubic feet, an outflow of 300 cubic feet per second, the latter figure being arrived at by assuming the maintenance of a minimum flow of the river at Rochester of at least 680 cubic feet per second.

EFFECT OF TAKING WATER SUPPLY FOR THE ENLARGED ERIE CANAL FROM THE UNREGULATED GENESEE RIVER.

Again referring to Tables Nos. 27 and 29, we have, in Column No. 2, the minimum flow which it is proposed to always maintain at Rochester. The figures of this column also include the amount to be furnished to the canal as given separately in Column 6. Column No. 3 gives the natural flow of the Genesee river at Rochester, as determined by computation from proportionality of drainage areas from the Mount Morris gagings for the period covered;

Column No. 4 is the natural flow at Portage determined in the same way; Column No. 5 gives the flow at Rochester, less the flow at Portage; Column No. 6, the amount required for the canal, as already indicated. In Column No. 7 we have the ratio of the amount going to the canal to the actual flow at Rochester for the months indicated; that is, we have the quantity of Column 6 divided by the quantity of Column 7. Without referring to all the the figures of Column No. 7, we may point out that had the enlarged Erie canal been in operation in July, 1894, and taking the estimated quantity of 80 cubic feet of water per second from the Genesee river, the amount of water going to the canal would have been 27.4 per cent. of the total flow of the river for that month; in August the amount for the canal would have been 18.1 per cent. of the whole. In May, 1895, the amount taken by the canal would have been 46 per cent. of the whole flow of the river for that month; in June of that year, 28.3 per cent; July, 34.5 per cent.; August, 31.5 per cent; September, 36.2 per cent.; October, 34.8 per cent. In May, 1896, the canal would have taken 51.3 per cent of the total flow of the river for that month; June, 12.2 per cent.; July, 15.9 per cent.; August, 19.2 per cent. and in September, 24.5 per cent. We learn, therefore, from Columns 6 and 7 that the taking of the 80 cubic feet per second from the Genesee river for canal purposes is a very serious matter to the water power of the stream. In Column No. 8 we have the minimum amount of water to be added at Portage in order to maintain 1,000 cubic feet per second at Rochester. The figure of this column is without .eference to the 457 cubic feet per second which, as already shown, it is proposed to discharge anyhow in the interests of the upper part of the stream. Column No. 9 gives the actual quantity available at Rochester for power purposes in cubic feet per second for each month of the period considered. In describing Column No. 10 we will, for convenience sake, refer to the data of Table No. 29, it being understood that the columns of both Tables Nos. 27 and 29 are the same, Table No. 27 applying to a reservoir of 7,500,000,000 cubic feet capacity and Table No. 29 to one of 15,000,000,000 cubic feet capacity. Column No. 10 shows the actual outflow from Portage

TABLE

Showing the State of the Portage Reservoir, from month
least 300 *cubic feet per second always flowing at Port*
the amount required for the canal at Rochester.

(In inches on the tributary wat

MONTH.	Runoff = inflow to reservoir.	OUTGO FROM I	
		Evaporation.	Amount to stream.
(1)	(2)	(3)	(4)
1894.			
June	1.10	0.03	0
July	0.14	0 04	0
August	0.22	0.04	0
September	0.93	0.03	0
October	0.44	0.02	0
November	0.82	0.01	
December	0.61	0.01	
1895.			
January	0.66	0.01	
February	0.22	0.01	
March	1 94	0.01	
April	2.01	0.02	
May	0.19	0.04	
June	0.13	0.04	
July	0,11	0.03	
August	0.12	0.03	
September	0.10	0.02	
October	0.11	0.01	
November	0.47	0.01	
December	1.32	0.01	
1896.			
January	0.47	0.01	
February	0.91	0 01	
March	3.00	0.01	
April	3.38	0.02	
May	0.17	0.03	
June	0 39	0 04	
July	0.24	0.04	
August	0.20	0.04	
September	0.16	0.02	
October	1.74	0.02	
November	0.82	0.01	

No. 28.

... to month, from June, 1894, *to November,* 1896, *with at ... age, and at least* 600 *cubic feet per second over and above*

...ershed of 1,000 square miles.)

...eservoir.						
...	Total outgo, sum of (3) and (4).	Excess.	Deficiency.	Amount in reservoir at end of month.	Wasted.	Remarks.
	(5)	(6)	(7)	(8)	(9)	(10)
83	0.36	....	....	3 72	0.72	Reservoir full at beginning and end of June. (3.25 inches = total storage, reservoir full.)
59	0.63	....	0.49	2.76	....	
49	0 53	....	0.31	2.45	....	
33	0.36	0.57	....	3.02	....	
35	0.37	0.07	....	3.09	....	
33	0.34	0.48	....	3 25	0.32	
35	0.36	0.25	....	3.25	0.25	
35	0.36	0.30	....	3.25	0.30	
33	0 34	....	0.12	3.13	....	
35	0.36	1.58	....	3.25	1.46	
33	0.35	1.66	....	3.25	1.66	
34	0.68	....	0.49	2.76	....	
36	0.62	....	0.49	2.27	....	
33	0.66	....	0.55	1 72	....	
61	0.64	....	0.52	1.20	....	
32	0.64	....	0.54	0.66	....	
31	0.62	....	0.51	0.15	....	
33	0.34	0.13	....	0.28	....	
35	0.36	0.96	....	1.24	....	
35	0.36	0.11	....	1.35	....	
32	0.33	0.58	....	1.93	....	
35	0.36	2.64	....	3.25	1.32	
33	0.35	3.03	....	3.25	3.03	
57	0.70	....	0.53	2.72	....	
34	0.38	0.01	....	2.73	....	
45	0.49	....	0.25	2.48	....	
51	0,55	....	0.35	2.13	....	Total waste from June 1, 1894, to December 1, 1896, equals 9.36 inches.
57	0.59	....	0.43	1.70	....	
35	0.37	1.37	....	3.07	....	
33	0.34	0.48	....	3.25	0.30	

TABL

Showing the regulation of the Genesee river effected June, 1894, to November, 1896, inclusive; together and its ratio to the natural flow of the stream.— at Portage, and at least 1,000 cubic feet per secon Roohester.

MONTH.	Proposed minimum flow to be maintained at Roohester—cubic feet per second.	Natural flow at Rochester—cubic feet per second.	Natural flow at Portage—cubic feet per second.
(1)	(2)	(3)	(4)
1894.			
June	1,080	2,321	981
July	1,080	292	123
August	1,080	442	187
September	1,080	1,963	830
October	1,080	899	380
November	1,080	1,729	731
December	1,000	1,256	531
1895.			
January	1,000	1,335	565
February	1,000	495	209
March	1,000	3,985	1,684
April	1,000	4,257	1,800
May	1,177	385	163
June	1,080	283	120
July	1,080	232	98
August	1,080	254	108
September	1,080	221	93
October	1,080	230	97
November	1,080	993	420
December	1,000	2,710	1,146
1896.			
January	1,000	964	408
February	1,000	2,005	848
March	1,000	6,158	2,604
April	1,000	7,172	3,033
May	1,177	347	147
June	1,080	654	277
July	1,080	501	211
August	1,080	416	176
September	1,080	327	138
October	1,080	3,667	1,556
November	1,080	1,728	731

No. 29.

a storage at Portage of 15,000,000 *cubic feet from*
ith the amount of water required for canal purposes
ith at least 457 *cubic feet per second always flowing*
over and above the amount required for the canal at

per second.	Amount to canal—cubic feet per second.	Ratio of amount to canal to actual flow $=\frac{(6)}{(5)}$	Minimum amount to be added at Portage in order to maintain 1,000 cubic ft. per second at Rochester—cubic feet per second.	Quantity available at Rochester for power purposes—cubic feet per second—(5)+(10)+(11)—(6).	Actual outflow from Portage reservoir—cubic feet per second.	Surplus flowing over spillway at Portage reservoir—cubic feet per second.	Column (10) in inches on the watershed.
)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
340	80	0.035	....	1,717	457	521	0.51
169	80	0.274	911	1,000	911	....	1.05
255	80	0.181	825	1,000	825	....	0 95
133	80	0.041	....	1,500	457	....	0.51
519	80	0.089	561	1,000	561	....	0.65
998	80	0.046	82	1,375	457	....	0.51
725	....	....	275	1,181	457	....	0.53
770	....	....	230	1,227	457	....	0.53
286	....	....	714	1,000	714	....	0.74
301	....	....	....	2,758	457	....	0.53
457	....	....	....	3,972	457	1,058	0.51
222	177	0.460	955	1,000	955	....	1.10
163	80	0.283	917	1,000	917	....	1.02
134	80	0.345	946	1,000	946	....	1.09
146	80	0.315	934	1,000	934	....	1.08
128	80	0.362	952	1,000	952	....	1.04
133	80	0.348	947	1,000	947	....	1.09
573	80	0.081	507	1,000	507	....	0.56
564	....	....	....	2,021	457	....	0.53
556	....	....	444	1,013	457	....	0.53
157	....	....	....	1,614	457	....	0.49
554	....	....	....	4,011	457	....	0.53
139	....	....	....	4,946	457	350	0.51
200	177	0.513	977	1 000	977	....	1.13
377	80	0.122	703	1,000	703	....	0.78
290	80	0.159	790	1,000	790	....	0.92
240	80	0.192	840	1,000	840	....	0.97
189	80	0.245	891	1,000	891	....	0.99
111	80	0.021	....	2,488	457	....	0.53
997	80	0.046	83	1,454	457	....	0.51

reservoir in cubic feet per second for each month of the period. In those months when the natural flow of the unregulated portion of the drainage area would sustain a flow of at least 1,000 cubic feet per second at Rochester, with an addition of 457 cubic feet per second at Portage then only that amount is added. In months when the natural flow would not have sustained 1,000 cubic feet per second at Rochester, with 457 cubic feet per second added at Portage, then an additional amount is added there sufficient to maintain the 1,000 cubic feet at Rochester. Just how this adjustment operates may be easily gathered by a slight study of the table. In Column No. 11 we have the quantities, in Column No. 10 in inches on the watershed.

Referring to Tables Nos. 28 and 30, we have, in Column No. 2, the runoff of the stream in inches on the watershed, as taken from Table No. 2. Columns 3, 4 and 5 show the outgo from the reservoir, Column 3 giving the evaporation from the reservoir surface, as derived from Table No. 6; Column No. 4 indicates the amount actually going to the stream as per Column No. 11 of Tables Nos. 27 and 29; Column No. 5 is the sum of Columns 3 and 4, and represents the total outgo from the reservoir both from evaporation and amount to the stream. In Column No. 6 we have the excess quantities, that is to say, in any month when the total of Column No. 2 is greater than that of Column No. 5 the difference carried into Column No. 6 is excess. It represents the net addition to the storage for that month; on the contrary, in those months when the total of Column No. 2 is less than Column No. 5 the difference goes into Column No. 7 and represents the net reduction of the storage in inches on the watershed for that month. Column No. 8 represents the state of the reservoir at the end of each month. For instance, at the end of June, 1894, the reservoir was full — it contained 6.46 inches on the watershed. In July the deficiency was 0.97 inches, leaving the reservoir at the end of that month with a storage of 5.49 inches. In August the deficiency was 0.8 inches, leaving the storage in the reservoir at the end of that month 4.69 inches, and so on.

DAMAGE TO THE WATER POWER OF THE GENESEE RIVER RESULTING FROM TAKING THE WATER SUPPLY OF THE ENLARGED ERIE CANAL FROM THE UNREGULATED RIVER.

Having determined that the enlarged Erie canal will at times draw as much as 50 per cent. of the unregulated flow of the Genesee river, we may now compute, as far as necessary for the present discussion, the damage to the water power of the stream by reason of such taking. As shown on a previous page, the minimum flow of the river is capable of producing power to the amount of 6,727 gross horse power, or, what is the same thing, assuming 75 per cent. efficiency, 5,046 net horse power. One-half of the low-water power may, therefore, be taken at 2,523 net horse power.

So long as the possibility exists of a draft upon the river equal to one-half of its minimum flow, this 2,523 net horse power is practically rendered useless to its owners by reason of the uncertainty as to just when the draft will occur.

If we refer to the photographs, Plates XXIII and XXIV, we will observe that although Rochester is a manufacturing town depending apparently, upon the water power of the Genesee river, still nearly every manufacturing establishment has a chimney connected with it. This fact is especially brought out on Plate XXIII, which is a view of the mills taking their water supply from Brown's race. According to statistics furnished by the Rochester Chamber of Commerce, 500,000 tons of coal are used in the production of steam per year at Rochester. The average price for steam coal at Rochester is $2.40 per ton, hence the steam power of Rochester expends for coal alone the sum of $1,200,000 per year, or about one-half of the entire cost of the Portage reservoir. Without going into a canvass of just the conditions at every mill, it may be assumed as settled on the evidence of Plates XXIII and XXIV that whenever there is a deficiency in the water power, steam engines are called upon to do the work. As to the cost of steam power, reference may be made to Table No. 14, showing the cost of Steam Power, in the report of the Upper Hudson storage for 1895.

TABLE

Showing the state of the Portage reservoir from mon
at least 457 *cubic feet per second always flowing*
over and above the amount required for the canal

(In inches on the tributary wa

MONTH.	Runoff—inflow to reservoir.	OUTGO FROM R	
		Evaporation.	Amount to stream.
(1)	(2)	(3)	(4)
1894.			
June	1.10	0.05	0 5
July	0.14	0.06	1.0
August	0.22	0.07	0.9
September	0.93	0.04	0.5
October	0.44	0.03	0.6
November	0.82	0.02	0.5
December	0.61	0.01	0.5
1895.			
January	0.66	0.01	0 5
February	0.22	0.01	0.7
March	1.94	0.02	0.5
April	2.01	0.03	0.5
May	0.19	0.06	1.1
June	0.18	0.06	1.0
July	0.11	0.05	1.0
August	0.12	0.04	1.0
September	0.10	0.03	1.0
October	0.11	0.02	1.0
November	0 47	0.01	0.5
December	1.32	0.01	0.5
1896.			
January	0.47	0.01	0.5
February	0.91	0.01	0.4
March	3.00	0.02	0.5
April	3.38	0.03	0.5
May	0.17	0 05	1.1
June	0.39	0.05	0.7
July	0.24	0.06	0.9
August	0.20	0.05	0.9
September	0.16	0.03	0.9
October	1.74	0.02	0.5
November	0.82	0.02	0 5

Serial number.	PLACE.	Designation of dam or race.	
(1)	(2)	(3)	
1	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
2	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
3	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
4	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
5	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	sing 29 second.
6	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
7	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
8	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
1	Geneseo		
1	York		
1	Rochester	Carroll & Fitzhugh Race	
2	Rochester	Carroll & Fitzhugh Race	
3	Rochester	Carroll & Fitzhugh Race	
4	Rochester	Carroll & Fitzhugh Race	
5	Rochester	Carroll & Fitzhugh Race	
6	Rochester	Carrall & Fitzhugh Race	
7	Rochester	Carroll & Fitzhugh Race	
8	Rochester	Carroll & Fitzhugh Race	
9	Rochester	Carroll & Fitzhugh Race	
10	Rochester	Carroll & Fitzhugh Race	
1	Rochester	Johnson & Seymour Race	
2	Rochester	Johnson & Seymour Race	
3	Rochester	Johnson & Seymour Race	
4	Rochester	Johnson & Seymour Race	
5	Rochester	Johnson & Seymour Race	
6	Rochester	Johnson & Seymour Race	
7	Rochester	Johnson & Seymour Race	
8	Rochester	Johnson & Seymour Race	
9	Rochester	Johnson & Seymour Race	
10	Rochester	Johnson & Seymour Race	
11	Rochester	Johnson & Seymour Race	
12	Rochester	Johnson & Seymour Race	
13	Rochester	Johnson & Seymour Race	
14	Rochester	Johnson & Seymour Race	
15	Rochester	Johnson & Seymour Race	

The [illegible]

[illegible]

Serial number.	PLACE.	Designation of dam or race.	
(1)	(2)	(3)	
1	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
2	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
3	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
4	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
5	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	ısing 29 second.
6	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
7	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
8	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
1	Geneseo		
1	York		
1	Rochester	Carroll & Fitzhugh Race	
2	Rochester	Carroll & Fitzhugh Race	
3	Rochester	Carroll & Fitzhugh Race	
4	Rochester	Carroll & Fitzhugh Race	
5	Rochester	Carroll & Fitzhugh Race	
6	Rochester	Carrall & Fitzhugh Race	
7	Rochester	Carroll & Fitzhugh Race	
8	Rochester	Carroll & Fitzhugh Race	
9	Rochester	Carroll & Fitzhugh Race	
10	Rochester	Carroll & Fitzhugh Race	
1	Rochester	Johnson & Seymour Race	
2	Rochester	Johnson & Seymour Race	
3	Rochester	Johnson & Seymour Race	
4	Rochester	Johnson & Seymour Race	
5	Rochester	Johnson & Seymour Race	
6	Rochester	Johnson & Seymour Race	
7	Rochester	Johnson & Seymour Race	
8	Rochester	Johnson & Seymour Race	
9	Rochester	Johnson & Seymour Race	
10	Rochester	Johnson & Seymour Race	
11	Rochester	Johnson & Seymour Race	
12	Rochester	Johnson & Seymour Race	
13	Rochester	Johnson & Seymour Race	
14	Rochester	Johnson & Seymour Race	
15	Rochester	Johnson & Seymour Race	

Serial number.	PLACE.	Designation of dam or race.	
(1)	(2)	(3)	
1	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
2	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
3	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
4	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
5	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	using 29 … second.
6	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
7	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
8	Mount Morris	Mount Morris Hydraulic Power Co.'s Race	
1	Geneseo		
1	York		
1	Rochester	Carroll & Fitzhugh Race	
2	Rochester	Carroll & Fitzhugh Race	
3	Rochester	Carroll & Fitzhugh Race	
4	Rochester	Carroll & Fitzhugh Race	
5	Rochester	Carroll & Fitzhugh Race	
6	Rochester	Carrall & Fitzhugh Race	
7	Rochester	Carroll & Fitzhugh Race	
8	Rochester	Carroll & Fitzhugh Race	
9	Rochester	Carroll & Fitzhugh Race	
10	Rochester	Carroll & Fitzhugh Race	
1	Rochester	Johnson & Seymour Race	
2	Rochester	Johnson & Seymour Race	
3	Rochester	Johnson & Seymour Race	
4	Rochester	Johnson & Seymour Race	
5	Rochester	Johnson & Seymour Race	
6	Rochester	Johnson & Seymour Race	
7	Rochester	Johnson & Seymour Race	
8	Rochester	Johnson & Seymour Race	
9	Rochester	Johnson & Seymour Race	
10	Rochester	Johnson & Seymour Race	
11	Rochester	Johnson & Seymour Race	
12	Rochester	Johnson & Seymour Race	
13	Rochester	Johnson & Seymour Race	
14	Rochester	Johnson & Seymour Race	
15	Rochester	Johnson & Seymour Race	

also made by Mr. Kibbe during his studies, in 1890, from June 17 to December 2, 1890.*

Unfortunately the gagings established by Mr. Kibbe were not kept up, and we accordingly have a gap of nearly three years from the end of the work done by him to its re-establishment in 1893. The dam over which these gagings have been kept is the old State dam now belonging to the Mount Morris Hydraulic Power Company. The crest of this dam is quite irregular, and, in order to apply weir formulae to it, an accurate profile was taken and the dam divided into a number of approximately level sections with each section computed separately for various heights, advancing by 0.1 feet up to 10 feet. Working on this plan, the flow over the entire dam, which is 337 feet in length, is obtained by adding together the sums of the several sections at the corresponding heights and tabulating the same. A gage graduated to 0.05 feet was set up on the river bridge, a short distance away, with its zero level with the lowest point on the dam. During ordinary stages of the river readings of this gage have been taken twice each day; in time of high water, in order to obtain the movement of floods as accurately as possible, readings have been taken several times a day. In order to compute the flow readily, a curve was projected embodying the data of the tabulation previously referred to for the entire dam, and from which, with the given gage heights, the flows in cubic feet per second could be quickly read off.

As best suited to the form of the dam, the formula

$$Q = 1{,}142\ h^{\frac{3}{2}}$$

as suggested by Mr. Kibbe, is used in computing the table of flow. In this formula

Q = cubic feet per second, and

h = head on the crest in feet.

In using this formula the leakage of the dam and discharge through the raceway of the Hydraulic Power Company was taken at a continuous outflow of 100 cubic feet per second.

*See Plate II, accompanying the Report on the Water Supply of the Genesee River Feeder. Appendix F, to the Annual Report of the State Engineer and Surveyor for the fiscal year ending Sept. 30, 1890.

The present writer having satisfied himself by observation that the results given by this formula were somewhat in excess of the truth, especially for the low water flows, a weir was constructed during the summer of 1896, at a point two and one-half miles above the Hydraulic Water Power Company's dam, where rock bottom clear across the river offers a convenient opportunity for such a construction without heavy expense. Plate K shows the method of constructing this weir, while the photographs, Plates XXXI, XXXII and XXXIII, show its appearance when completed. This weir was made perfectly water tight. As an interesting fact, it may be mentioned that the weir measurements entirely justified the general allowance of 100 cubic feet per second for leakage of Hydraulic Power Company's dam and draft of raceway as made three years ago.

In order to correlate the measurements at the Mount Morris Hydraulic Power Company's dam with those at the weir, two observations a day were taken at each place nearly cotemporaneously, that is to say, they were both taken by the same man, who passed immediately from the weir to the dam and *vice versa*. Observations on the weir were obtained up to a head of four feet, and the corresponding discharge computed with the proper allowance for velocity of approach, etc. The depths on the Hydraulic Power Company's dam corresponding to the given depths at the weir have been so plotted on a diagram as to give at once the relation between discharge at the weir and depth on the crest of the Hydraulic Power Company's dam. By proceeding in this way the dam has been rated accurately up to a discharge of 5,000 cubic feet per second. For discharges beyond 5,000 cubic feet per second the original determination has been used. An extension of the plotted curves shows that at some little distance above 5,000 cubic feet per second discharge, the results by the two methods are substantially the same. For discharges above 10,000 or 15,000 cubic feet per second there is probably still an error in the results of from 5 to 10 per cent. Below 5,000 cubic feet per second it is believed that the results are now accurate within 2 or 3 per cent.

Mr. Francis' formula

$$Q = 3.33 \, L \, h^{\frac{3}{2}}$$

has been used for the weir computations.

In constructing the weir it was intended to make it permanent enough to remain several years, in this way gaining a very accurate series of runoff records for this stream. Unfortunately, by reason of press of work, the weir was not entirely completed at the time of doing the work in July and August, but was merely so far advanced that it could be placed in immediate use. As shown by the photographs, Plates XXXI, XXXII and XXXIII, the west end abuts against an alluvial flat while the east end is against the solid shale rock. The plan, however, included the construction of some protection docking at the west end for the purpose of ensuring safety at that end during high water. This work, it was expected to complete about November 1, but a severe flood the middle of October carried out the bank at the west end, doing several hundred dollars damage. By reason of lack of funds, it has been found inexpedient to repair this break during the past season, although it is hoped to do so during the coming year. In the meantime the weir is necessarily out of service until the repair is made.

By applying the results obtained from the weir to the gagings taken in former years at the Hydraulic Power Company's dam, those results have been corrected to about the limits of accuracy already stated. In using the diagrams of stream flow, as given in the report on Genesee storage, dated April 1, 1894, these corrections should be borne in mind.

Gagings have also been kept by the City Engineer at Rochester for the last three years as given in Table No. 5. Column No. 1 of that table gives the monthly mean, as per the original record. From data obtained during the summer of 1895 it was apparent to the City Engineer that these gagings also required a correction in order to give the true flow of the stream during the period covered. Without going into the detail of the correction used, it may be stated that Column 2 of Table No. 5 gives the corrected results. Column No. 3 of that table gives the flow of the Genesee river at

Rochester proportionate to the drainage area as deduced from the gagings at Mount Morris. It has seemed to the present writer preferable to use these proportionate flows as being probably somewhat more reliable than the Rochester record. Just the difference between the two may be easily determined by comparing the different Columns of Table No. 5 in detail.*

SANITARY CONSIDERATIONS.

There is a popular idea that changes in the level of the ground water are a prolific source of disease, and that, therefore, the margins of a storage reservoir, where large fluctuations are inevitable, must necessarily be unhealthful. It is also urged that such a reservoir will be, when drawn upon, a source of bad smells, by reason of the exposure of mud margins, thus further producing unhealthful conditions. As regards the present reservoir, it is believed that both of these objections are myths purely. The sides of the Upper Genesee valley are of compact clay, into which the water will penetrate either not at all or only very slowly. On both sides the ground rises to a height of 200 or 300 feet above the high water level of the reservoir within a very short distance. The change in elevation of the ground outside of the valley will, therefore, be little or nothing. Moreover, as already stated, the timber and brush within the flowage area is to be all cut and burned, thus leaving everything clean at the time of beginning the flowage, hence there will be left no malaria making material.

Referring to Column No. 10 of Table No. 29, it is learned that during the period from June, 1894, to November, 1896, inclusive, the maximum draft from the Portage reservoir would have been at the rate of 955 cubic feet per second during the month of May, 1894. The mean inflow during the same month was at the rate of 163 cubic feet per second, thus making the net draft (955 — 163) =792 feet per second. Referring to Table No. 30 we learn that the total deficiency for the month of May, 1895, including the evaporation,

*The uncertainty as to the gagings at Rochester is due to the difficulty of measuring the flow through the raceways, which during medium and low water take the entire flow of the river.

was 0.97 inches on the watershed, and, also, that the reservoir would have fallen during that month from 6.46 inches to 5.49 inches. From Table No. 26 it is learned that a decrease in the storage of the reservoir from 6.46 inches to 5.49 inches would lower the water from elevation 1,200 to about elevation 1,194, a total fall during the month of 6 feet, or at the rate roundly of 0.2 feet per day. This rate of fall, it will be understood, would have occurred with a full reservoir. With the reservoir drawn partly down the rate would be somewhat faster, but under the ordinary conditions of draft of from 457 to 600 or 700 cubic feet per second, even then it would not generally be over from 0.3 to 0.4 feet per day. It is difficult to see, therefore, how the lowering of the water can expose mud margins rapidly enough to cause serious effluvium nuisance. Indeed, it may be assumed, then, that very little difficulty of this sort will be experienced.

AS TO THE PROPER LENGTH AND DEPTH OF SPILLWAY FOR THE PORTAGE RESERVOIR.

If we assume the runoff of a stream to pass directly over a dam without any special storage, we may compute the length of the spillway and the maximum depth thereon by the two following formulae derived from E. Sherman Gould, M. Am. Soc. C. E.*

$$L = 20 \times A^{\frac{1}{2}} \qquad (1)$$

$$D = A^{\frac{1}{3}} \times C \qquad (2)$$

in which

$L =$ length of crest in feet,

$D =$ total depth of water on the crest in feet,

$A =$ drainage area in square miles,

and $C =$ a coefficient, depending upon the assumed maximum discharge.

For a maximum discharge of 62 to 64 cubic feet per second per square mile, as derived from the experience data of the Croton watershed, we have—

$$D = A^{\frac{1}{3}} \qquad (3)$$

*Trans. Am. Soc. C. E., Discussion on Rainfall. Vol. XXVII, pp. 294-296.

That is, taking into account the drainage area of that stream and the actual flow observed, we have the relation indicated by formula (3).

On the assumption that $A^{\frac{1}{3}}$ is the proper depth on spillway for a discharge of 62 to 64 feet per second per square mile, the depth for any other quantity Q, may be obtained by multiplying $A^{\frac{1}{3}}$ by C as derived from the expression —

$$C^{\frac{2}{3}} = \frac{Q}{64} \quad \text{whence}$$

$$C = \frac{Q^{\frac{2}{3}}}{16} \qquad (4)$$

therefore the general form of the formula (2) may be written

$$D = A^{\frac{1}{3}} \times \frac{Q^{\frac{2}{3}}}{16} \qquad (5)$$

This gives the actual depth of water on crest of dam. In order to allow for wing walls we may further write—

$$D = \left[A^{\frac{1}{3}} \times \frac{Q^{\frac{2}{3}}}{16}\right] + C' \qquad (6)$$

in which

C' = distance from extreme high water mark to top of wing walls.

If we apply these formulae to the case of the Portage dam with an assumed flood flow of 64 cubic feet per second per square mile we determine that $L = 632$ feet, and $D = 10$ feet.

As stated in the beginning of this discussion, these two formulae are based upon the assumption of direct runoff without very large storage, and it accordingly becomes important to determine whether, when we take into account the temporary storage over the large area of the reservoir, we may not either materially decrease the length of spillway from the foregoing figure, or the depth thereon.*

The area of the Portage reservoir at the ordinary water level

*For the effect of the storage in increasing the length of time of the maxium runoff for a reservoir storing 7,500,000,000 cubic feet see discussion in Report on Genesee Storage of date April 1, 1894, in Annual Report State Engineer and Surveyor for the fiscal year ending Sept. 30, 1894, pp. 390-393.

(crest of spillway) is, as per Table No. 26, 12.3 square miles; at 10 feet above the ordinary water level it is 13.69 square miles. The volume included in this 10 feet is 3,461,000,000 cubic feet.

As in the discussion in the 1894 report, we will assume the most unfavorable case, namely, the water standing at the level of the crest at or near the beginning of a maximum runoff. The extreme condition as derived from Genesee drainage area data has been defined in the 1894 report and need not be further referred to here, but, by way of guiding us as to the law of the runoff, we may discuss the data of the flood of May 20-23, 1894, the approximate discharge of the stream at Mount Morris at that time being as follows:

May 18, 7.00 a. m.	600 cubic feet per second.
May 18, 6.00 p. m.	3,090 cubic feet per second.
May 19, 7.00 a. m.	5,530 cubic feet per second.
May 19, 6.00 p. m.	5,090 cubic feet per second.
May 20, 7.00 a. m.	16,580 cubic feet per second.
May 20, 12.00 m.	22,210 cubic feet per second.
May 20, 6.00 p. m.	28,000 cubic feet per second.
May 21, 3.30 a. m.	42,000 cubic feet per second.
May 21, 7.00 a. m.	33,000 cubic feet per second.
May 21, 12.00 m.	30,730 cubic feet per second.
May 21, 6.00 p. m.	26,500 cubic feet per second.
May 22, 7.00 a. m.	15,650 cubic feet per second.
May 22, 12.00 m.	13,650 cubic feet per second.
May 22, 6.00 p. m.	10,720 cubic feet per second.
May 23, 7.00 a. m.	7,300 cubic feet per second.
May 23, 12.00 m.	6,700 cubic feet per second.
May 23, 6.00 p. m.	5,690 cubic feet per second.
May 24, 7.00 a. m.	5,390 cubic feet per second.

The total runoff from 7 a. m. of May 19 to 7 a. m. of May 24 was nearly 6,900,000,000 cubic feet.

Plotting the foregoing record, with time as abscissas and runoff as ordinates, we obtain the lower curve of Plate L, which may be taken as representing approximately the law of the runoff from this stream for any generally distributed heavy rainfall.

It is not intended to state, however, that flood flows at other sea-

sons of the year may not differ somewhat in their movement from that of May, 1894, but, rather, inasmuch as the rapidity and intensity of the runoff of any given stream depends upon the topography, to state that the general law of movement is indicated by such curve as the lower one of Plate L. Hence, with this understanding, we may assume any other maximum runoff and construct the approximate curve by drawing it generally parallel to the curve of an actually observed case. In this way the upper curve of Plate L, representing the curve of a flood one and one-half times greater than that of May, 1894, has been produced, slight irregularities of the lower curve having been neglected in projecting the upper one.

A flood flow one and one-half times greater than that of May, 1894,

TABLE No. 32.

Showing the effect of temporary storage in reducing the height of water over the spillway in time of floods.

	C.	C′.	Q.	Q′.		t.	
Height above crest of spillway in feet.	Total storage above crest of spillway in cubic feet.	Intermediate values of C.	Discharge of spillway 730 feet long — cubic feet per second.	Mean values of Q.	Inflow in cubic feet per second (from diagram).	Time, in hours.	Total time, in hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0.25	90,733,500	90,733,500	306	153	8,900	2.880	2.880
0.50	181,467,000	90,733,500	884	595	11,750	2 260	5.140
0.75	272,200,500	90,733,500	1,643	1,264	14,550	1.890	7.050
1.00	362,934,000	90,733,500	2,551	2.097	17,150	1.674	8.724
1.25	453,567,500	90,733,500	3,577	3,064	19,450	1.538	10 262
1.50	544,401,000	90,733 500	4,725	4,151	21,650	1.440	11.702
2.00	725,868,000	181,467,000	7,288	6,006	24,900	2.668	14.370
2.50	907,335,000	181,467,000	10,185	8,736	29,000	2.488	16.858
3.00	1,088,802,000	181.467,000	13,366	11,776	33,000	2.375	19.233
3.50	1,270,269,000	181.467.000	16,787	15,076	37,100	2.289	21.522
4.00	1,451,736,000	181,467.000	20,407	18.597	41,400	2.210	23 732
4.50	1,633,203,000	181,467,000	24,228	22,318	45,850	2.147	25.879
5.00	1,814,670,000	181,467,000	28,185	26,206	50,550	2.071	27.950
5.50	1,996,137,000	181,467,000	32,295	30,240	55,500	1.995	29 945
6.00	2,177,604,000	181,467,000	36,547	34,421	60,250	1.951	31.896
6.50	2,359,071,000	181,467,000	40,972	38,760	63,000	2.080	33 976
7.00	2,540,538,000	181,467,000	45,419	43,196	59,600	3.130	37.106
7.50	2,722,005,000	181,467,000	50,020	....	....	....	....
8.00	2,903,472,000	181 467,000	54,718	....	....	....	....
8.50	3,084,939,000	181,467,000	59,396	....	....	....	....
9.00	3,266,406,000	181,467,000	64,250	....	....	....	....
9.50	3,447,873,000	181,467 000	68 925	....	....	....	....
10.00	3,629,340,000	181,467,000	73,900	....	....	....	....

Water in reservoir reaches a maximum height of seven feet over spillway in 37.1 hours. From this time on the water level of the reservoir is falling.

which culminated in a maximum of about 42,000 cubic feet per second at 3.30 a. m. of May 21st, gives a maximum of 63,000 cubic feet per second. According to the formulae of page 721, such a maximum would require a spillway about 630 feet long with a depth thereon at the instant of extreme flow of 10 feet. Let us now examine as to the effect of the temporary storage on the reservoir surface in increasing the time of the runoff and the consequent effect in decreasing the spillway requirement. Inasmuch as there is an opportunity at Portage to construct a spillway at both sides with a total length of 730 feet, we will use that figure in our computations.

Referring to the discussion in the 1894 report,* we may, by use of the formulae there given, deduce Table No. 32, in which Column No. 1 gives heigths above the crest of the spillway in feet and fractions of feet; Column No. 2, the total temporary storage above the crest for heights H as per Column 1; Column No. 4, gives values of Q=discharge in cubic feet per second for various heights H also as per Column 1; Column No. 6, the inflow in cubic feet per second as taken from the upper curve of Plate L; Column No. 7, the time in hours to reach the given height H at a given inflow; and Column No. 8, the total time required to reach any given height with the inflow as per Plate L.

Following the table through it appears that with the inflow as indicated by Plate L, the water would reach a maximum height of 7 feet over the spillway in 37.1 hours. From that time on the water level of the reservoir would be falling. Referring to Plate L, the interesting fact is brought out that the maximum height on the spillway would only be attained four hours after the instant of maximum flow of 63,000 cubic feet per second, and at that time the discharge over the crest would be at the rate of 45,000 cubic feet per second, the effect of the temporary storage having been to reduce the maximum discharge from 63,000 to 45,000 cubic feet per second. Referring to Column No. 2, it is also learned that the temporary storage on the surface of the reservoir would be for the

*Also see Mullin's Irrigation Manual, pp. 215-23, article on Reservoirs as Moderators of Floods.

assumed case about 2,600,000,000 cubic feet. The foregoing computation further shows that in the case of large reservoirs the length of spillway and depth thereon are only in a moderate degree functions of the maximum runoff. A distinction should therefore be made in the application of runoff formulae of the form of Mr. Gould's between reservoirs with large surface pondage and dams on streams with little or no pondage.

As to the probability of a flood flow of 63,000 cubic feet per second on the Upper Genesee area, reference may be made to the report of date April 1, 1894,* where it is shown that a flood of 67.1 cubic feet per second per square mile has occurred on the neighboring watershed of the Chemung river. This figure applied to the Upper Genesee would give a possible maximum runoff of 71,126 cubic feet per second. In view of this data, and also, further, in view of the vast importance of constructing the works so that they are absolutely beyond question, it has seemed desirable to give the spillway the liberal dimension of 730 feet length as already stated.

STORAGE OF THE FLATS.

In the report of 1894, the view has been taken† that because of the considerable storage in the flats between Mount Morris and Rochester, the ordinary flow at Rochester is proportionately considerably greater than at Mount Morris. The gagings during the dry years of 1895 and 1896, have modified that view to this extent, that in very dry years the flats after awhile drain out so that the flow at Rochester is not any greater proportionately than at points further up the river. In wet years, however, it is probably true that the flats do prolong the time of runoff, thereby increasing the flow at Rochester to a figure somewhat higher than it would be if the flats did not exist.

CONCRETE TESTS.

The 1893 work included an extensive investigation as to the value or different available materials which might be used in the construction of the proposed Genesee storage dam, for making

*Annual Report State Engineer and Surveyor for 1894, p. 388-389. †pp. 384-385.

concrete. For the results of the investigations made at that time reference may be made to the report dated April 1, 1894, in which a number of points are indicated as requiring further investigation in order to fully compass the whole subject of the applicability of concrete to a work of this character. Such investigations have accordingly been carried out during the past summer. About 500 experimental cubes, each of a foot, have been made. Inasmuch as the work of three years ago indicated the availability of concrete for such a structure as is here proposed, it has not been deemed necessary to complete the concrete experiments by crushing the blocks, and including the results as to their breaking strength in this report. On conference with the Honorable State Engineer and Surveyor, it seemed, on the other hand, desirable to allow the experimental blocks to attain some age before breaking. On this basis it has been proposed to leave them for a year, thereby gaining definite knowledge of the strength of concrete one year old. The blocks will be broken during the summer of 1897, and made the subject of a special report.

CONCLUSIONS.

By way of summation of the preceding discussion, we may draw the following conclusions:

(1) Of the several available sites for storage reservoirs on the Genesee river, that at Portage is preferable to all others by reason of affording the largest storage at the smallest cost per unit volume.

(2) In considering large storage projects there are certain preliminary steps which should be taken before arriving at a decision. Failure to take these steps was probably the main reason for the original assumption as to the superiority of the Mount Morris location.

(3) As the result of three years' gagings of the Genesee river, it is determined that the minimum flow of the stream may be as low as 6.67 inches on the watershed for an entire water year.

(4) The estimated cost of a reservoir in the Mount Morris canyon, storing 7,370,000,000 cubic feet is $2,785,000, giving a rate per million cubic feet stored of $377.88.

(5) Serious floods have occurred in the Genesee river at Rochester a number of times within the historical period, the most serious one being that of March, 1865. At least $1,000,000 damage accrued from this flood, some of which was chargeable to difficultly at the Erie canal aqueduct.

(6) A flood in April, 1896, was very nearly as severe as the flood of March, 1865.

(7) A study of existing conditions shows that the Genesee river drainage area has been nearly denuded of forest. Hence, severe spring floods are likely to frequently occur.

(8) As a tentative conculsion, based on the data at hand, we may say that deforestation of the drainage area may not only tend to increase floods somewhat, but it leads to material decrease in the amount of the annual runoff.

(9) A comparison of the conditions existing on the drainage area of the Upper Genesee river with those of the Upper Hudson, which is still largely in forest, shows a much less runoff under given conditions from the Genesee than from the Hudson, thus indicating the probable effect of the forest in increasing the runoff.

(10) As regards the Upper Genesee drainage area, the forest has been removed by land owners who have profited materially by such removal. The effect, however, has been to permanently injure every riparian owner on the stream; hence, it is proper that the State should expend money either in reforesting the area or in constructing river regulation works. Of these two the latter is preferable because the benefits can be realized in a few years.

(11) The proposed Portage reservoir will impound 15,000,000,000 cubic feet of water at a total cost of $2,600,000, or at a cost of $173.33 per million cubic feet stored.

(12) The proposed Portage reservoir, storing 15,000,000,000 cubic feet of water, is 500 feet higher than the proposed Mount Morris reservoir, storing 7,340,000,000 cubic feet, and affords a total permanent continuous power over and above the present low water power of the stream of 50,496 gross horse power, whereas the reservoir at Mount Morris would afford only 11,600 gross horse power over and above the present low water power of the stream.

(13) Capitalizing the value of the permanent power produced by the construction of the Portage reservoir at 4 per cent. and we reach a total of $12,624,000. On the other hand, a capitalization of the total value of the permanent power produced by the proposed Mount Morris reservoir yields a total of only $2,900,000; hence, the difference in the capitalization at 4 per cent. becomes $9,724,000.

(14) The estimated cost of the reservoir at Portage, storing 7,500,000,000 cubic feet, is $1,800,000, or nearly $1,000,000 less than for a reservoir storing substantially the same quantity at Mount Morris.

(15) In order to provide an adequate water supply for the enlarged Erie canal it is necessary to construct a storage reservoir on the Genesee river of 2,500,000,000 cubic feet capacity. Such a reservoir is estimated to cost at Portage $1,350,000.

(16) The estimated cost of a dam storing 2,500,000,000 cubic feet, but with such breadth of base as to admit of extension to the full height required for the storage of 15,000,000,000 cubic feet is $1,700,000.

(17) Based on manufacturer's ratings, the present total developed water power of the Genesee river from Portage to Rochester, inclusive, is 19,178 net horse power, or basing the amount of power on the manufacturer's rating of water required, and assuming 75 per cent. efficiency on the wheels, the total power is 17,248 net horse power, of which 16,683 net horse power is within the limits of the city of Rochester.

(18) The enlarged Erie canal will require 80 cubic feet of water per second from the Genesee river for every month of the navigation season except May, and in that month a mean of 177 cubic feet per second.

(19) The present extreme low water power of the Genesee river at Rochester is 5,046 net horse power, of which one-half, or 2,523 net horse power will be rendered practically useless to its owners by reason of the taking of 80 cubic feet per second in every month except May, and 177 cubic feet per second in that month, for the purpose of the enlarged Erie canal.

(20) Taking the actual rental price of power in Rochester, and

we deduce an annual value for 2,523 horse power of $126,150. The capitalization of this sum at 4 per cent. becomes $3,153,750. If we add thereto the additional damage to the water power by reason of proposed appropriation for the enlarged Erie canal we reach at 4 per cent. capitalization about $3,300,000. It is in view of such injury to the water power of the stream that the riparian owners ask that the State construct the Portage reservoir substantially as herein proposed.

I wish to express my appreciation of the service rendered on this work by Wallace Greenalch, Assistant Engineer, who was constantly on the work in charge of the survey parties. Except for his diligence we could not have accomplished as much for the money. Messrs. George H. Schillner and A. M. Evans are also entitled to special mention for intelligent work on the plans.

Mr. Clarke's report on the geological conditions involved in the construction of the proposed Portage reservoir is herewith appended; also the specifications as prepared under the authority of the clause of Chapter 950; also a brief account of some of the more interesting high dams abroad as visited by the undersigned two years ago.

Very respectfully,

GEO. W. RAFTER,

Engineer in Charge.

The Geologic Conditions at the Site of the Proposed Dam and Storage Reservoir on the Genesee River at Portage.

By John M. Clarke.

George W. Rafter, Esq., *Engineer in Charge, Genesee Storage Reservoir:*

Sir.—Shortly after receiving your request that I examine, from a geological view-point, the site of the proposed dam and storage reservoir upon the Genesee river at and southward of the village of Portageville, I made it my business to visit and inspect the region, spending several days in the valley between the lower Portage falls and Caneadea village.

The points of practical importance in which the geologic structure of the region in question throws light upon the problems, mechanical and otherwise, involving the feasibility, construction and endurance of such a dam as that proposed, are comparatively few in number. The valley is one of simple origin and structure, like the vast majority of all water-courses in central and western New York; the gradual outcome of direct and progressive erosion through undisturbed and essentially homogeneous rock masses. Both erosive power and effect have varied greatly throughout the vast stretches of time since the present channel of the Genesee river was outlined, and the study of the origin of the existing topography in that region shows that the direction of the water movement through this valley was, for eras, nearly the reverse of its present flow, but all this has transpired without essential modification of the meridional direction of the valley itself.

The following considerations may be instanced as of primary importance to the matter under consideration:

(1.) The nature of the rock formation which is to form the base and side foundation of the masonry of the dam.

(2) The geologic composition of the hills bounding the valley and making the lateral and, in an important degree also, the terminal impounding walls of the reservoir.

(3.) The relation of the topography to the proposed elevation of the water-line.

(4.) The rate of erosion of the rock in the bed of the river along the gorge and at the succession of cataracts below, or north of the dam site.

These points I shall discuss categorically, incorporating under the specified captions any additional matters of accessory importance.

(1.) THE NATURE OF THE ROCK FORMATION UPON WHICH THE DAM IS TO REST.

The beautiful exposure of the rock strata along this valley from Portageville to Mt. Morris is that which gave rise to the geologic term, *Portage group*, introduced by the State Geologist, James Hall, in 1840. This name as restricted in its original application concerned only those strata which are shown in the high banks at and above the upper cascade, but its significance was broadened by the same author in a later and more elaborate consideration of these rocks in 1843.* The present scope of this term, Portage Group, remains now essentially as it was then redefined and embraces a series of minor formations which it is important here to pass under brief review.

The basal member of the Portage group is a mass of soft olive or dark argillaceous shales having thin sandstone beds interspersed throughout its extent, and embracing also one or more bands of black, bituminous shales. This division has been known as the

*Geology of New York; Report on the Fourth Geological District.

Cashaqua shales, the name being taken from the valley next adjoining the Genesee on the east and entering it at Mount Morris. The thickness of these beds varies in different sections from 75 to 250 feet.

Overlying them follow sandy shales with abundant beds of these sandstones and flags, which have been termed, from the old Indian reservation north of Portage, the *Gardeau flags*. These beds attain a thickness of from 300 to 500 feet, and, by a gradual increase in their amount of arenaceous matter, pass into a series of thicker sandstones with thinner intervening layers of shale. The sandstones which constitute the upper member of the Portage group, as defined in 1843, are known as the *Portage sandstones*. They attain a thickness of not less than 100 feet.

It will be understood that the passage from each of the rock divisions into its successor is extremely gradual, and to such a degree that a differentiation of the beds is impracticable except from the sum of the characters of each; to tell where one division ends and another begins is impossible, nor does such nomenclature imply any such distinction.

The Cashaqua shales are exposed along the Genesee river for a considerable distance at and northward of St. Helena; the Gardeau flags are finely exhibited in the gorge below Portageville, at the lower, middle and even to the upper falls.

The site of the proposed dam is on the uppermost of these rock divisions, the Portage sandstones. I therefore notice the character of this formation in further detail.

THE PORTAGE SANDSTONES.

In passing upward from the more shaly and argillaceous formation beneath we assume these beds to begin with the preponderance of silico-feldspathic sandstone strata, which attain a uniformly increasing thickness upward; that is to say, toward the base of the division these sandstones are a foot or more in thickness and, though frequently repeated, separated by shale deposits; near and at the top single strata may attain a thickness of 8-12 feet and shaly partings become quite inconspicuous.

Composition.— Throughout the Portage group the sandstone and flag layers vary very considerably in composition. As a rule, the thinner layers are more siliceous and micaceous, and hence harder, more brittle, but more resistant to uniform wear.

Frequently the lighter colored, grey and whitish layers are highly feldspathic, that is, contain silicates more or less readily soluble, and may contain specks of oxidized or unoxidized iron sulphides. This is the prevailing character of the thick beds of the Portage sandstones. The rock is grey or greenish grey in color, a mixture of siliceous and feldspathic sand, with a silico-calcareous cement, sometimes slightly compromised with iron sulphides, but seldom seriously. It is a very useful stone for architectural purposes involving no severe strain, is extensively quarried at various spots in western New York (Nunda, Castile, Warsaw), and very handsome stone is taken from the uppermost layers at the Genesee quarries a few miles south of Portageville. Its uniform grain and imperfect retention of lines of sedimentation make it almost a freestone; its composition permits it to be readily dressed and its soft tints make it susceptible of very pleasing effects; its feldspathic constitution, however, puts it at the mercy of meteorologic agencies and prevents its being classed among construction stones of high grade.

However useful and effective these sandstones may have proven for certain architectural purposes, it is not likely that they can be utilized in any important degree in the actual construction of the proposed dam. The predominance of feldspathic sand in their composition and the weakness of the usually calcareous cement holding the sand grains together, renders their crushing index low and the rocks susceptible to disintegration under ordinary atmospheric agencies. In such a way cohesion becomes gradually destroyed and the potential horizontal partings developed. While the rock may be found of some use in coarser incidental work and in the manufacture of concrete, your requirements will doubtless compel you to abandon the Portage group of rocks altogether as a source of construction material for the faces or foundation of

the dam. The rocks of the Chemung group, which cover nearly the entire southern tier of counties in the central and western part of the State, would furnish a much more siliceous and durable sandstone. This formation has yet been exploited only in a desultory fashion and its supply is in enormous excess of the product. In view of this fact, I venture to suggest that if actual workings in the Chemung formation within reasonable shipping distance of the dam site are not producing a suitable stone for your purposes, a practical geologist be sent into the field for the purpose of locating any possible deposit of such suitable stone. A brief exploration of the region would determine definitely whether or not satisfactory material could be obtained within easy reach of your structure.

The Dam Site.— The base of the dam and its sides are to lie in the lower part of the Portage sandstones. This position, in respect to stability of the underlying rock and its capacity for resisting the superimposed strains, could not be surpassed at any point in this entire region of the State, inasmuch as nature has forbidden the erection of such a structure on the heavy cap-stones of the Portage sandstone series.

The rock walls at the dam site, and from there to the base of the upper falls, show very clearly the quick alternation of thick and thin sandstones with shales, and the same characters are forcibly exhibited in the cores from the drillings made at the site.

Comparison of the Site at Portage with the former proposed sites near Mount Morris.— The sites lying from ten to fifteen miles further north and which have been discussed in your previous reports as Sites I, II, III and IV, lie on rock beds of earlier age and greater geologic depth. Sites III and IV appear to be in the lower part of the Portage series which we have already mentioned as the Cashaqua shales; but as the Sites I and II are those to which more serious consideration has been given, we may notice here the nature of the rock formation in which they lie. This is a mass of black, often highly bituminous fissile rock, known as the *Genesee slate.* Its lower beds through a thickness of about 75 feet are very compact and homogeneous, but its upper beds, of about

the same thickness, are much more shaly and carry a noticeable percentage of sand. The formation is divided at or near the middle by a thin limestone layer of a peculiar organic composition, and remarkable for its continuity from Erie county on the west to Yates county on the east. It is known as the Styliola or Genundewa limestone; upon it rests the old State dam on the Genesee river at Mount Morris. Former Sites I and II lie south of this dam and are hence upon the upper beds of this Genesee slate. This is a rock which upon horizontal exposure of the strata very rapidly crumbles, not by decomposition, but by rapid breaking up or checking along latent planes of original sedimentation or undeveloped joint-cleavage planes. Where unexposed the rock is sufficiently firm and durable, but the entire formation has been of such a nature as to respond much more readily to the action of vertical and lateral pressure than the higher Portage beds, and is hence far more insidiously cracked and jointed than is the case with the latter, and it may be very seriously doubted whether the utmost precaution in guarding against these existing but unseen lines of weakness would, in the case of severe vertical strain, be a guaranty of safety. In the matter of stability of the natural foundation, there can be no question of the vast superiority of the site at Portage.

Cleavage and Joints in the Portage Sandstones.— As these beds lie in a nearly horizontal position with a slight southerly dip, showing only here and there gentle undulations of approximately N-S axes, no question need arise as to their continuity along definite and well known E-W lines. The rocks have, however, in common with all similar sedimentary deposits, been naturally fractured or cleft. Such partings in the rocks are due to two causes; the first, and of far the more ancient date, is the original mode of horizontal deposition of the sediment, which has determined the lines of lamination or the evident horizontal bedding of sandstones and shales; the second, the pressure, both vertical and lateral, to which these sediments have been subjected since their deposition. The vertical pressure has intensified the disposition to horizontal cleavage, and has even made sandstone beds schistose, while the lateral

pressure has produced the vertical joints and seams which alone require further consideration here.

In beds of argillaceous rock maintaining a uniform grain, as for example, the bituminous beds of the Genesee slate, these lines of jointing are so perfectly developed that they may be traced continuously through the entire thickness of an exposure. Under such circumstances, too, they are numerically abundant, occurring at intervals of a fraction of an inch to a few feet. A series of joints having a given direction was produced by a given pressure at right angles thereto, but with the change in the direction of the pressure other sets of joints appear, so that such rock bed may be checked into a veritable mosaic and this character continued to considerable depths. It is to be clearly understood that, though in fresh exposures or drill cones, neither vertical or horizontal partings may be apparent, and the rock seems to be firm and continuous, yet the planes of parting have been defined by the pressure and exposure alone is required to develop them.

When one is confident that a rock formation of this kind itself rests upon a more substantial foundation, then only should it be assumed as the substratum of a heavy vertical strain.

The highly heterogeneous character of the Portage formation, with its alternating beds of shale and sandstone, has rendered it less responsive to such pressures. Everywhere may be seen evidences of vertical joints, but they are not only far less numerous than in the Genesee slate below, but the vast majority of them rarely pass from the particular bed of sandstone or shale in which they occur. Differences in the elasticity of the beds often give to each bed a set of joint planes peculiarly its own. Frequently the stronger joints do transect successive beds, but my observations of such instances lead me to the conviction that such joints are not of great vertical extent. Nor are these joints to be regarded as lines of weakness in such a region as this and with such geologic conditions as here prevail. There are here neither anticlinal folds nor underlying limestone beds, either of which might be a source of caverns permitting displacement along the joint planes.

Excavations for the foundation of the proposed dam, carried into

the rock at the base and sides far enough to be within the weather line will, in case the freshly exposed rock is carefully sealed from further exposure, probably be a sufficient precaution against displacements from this source.

THE GEOLOGIC COMPOSITION OF THE HILLS BOUNDING THE VALLEY AND MAKING THE LATERAL AND TERMINAL IMPOUNDING WALLS OF THE RESERVOIR.

The basal rock foundation of the Genesee valley from Portageville southward to Caneadea is not materially different from the strata already discussed as presented in the exposures about the dam site. The Portage sandstones are continued to the south to the vicinity of Wiscoy and Rossburg, where they are overlaid by arenaceous beds with large amounts of shale. The formation from there southward for a thickness of about 300 feet reassuming the aspect of the lower beds of the Portage group. This departure in lithologic character, emphasized by evidence derived from the study of the organic remains which they contain, has rendered it advisable to give these higher beds a distinctive term, the *Wiscoy beds*, from their fine exposure along the banks of the Wiscoy creek. About two miles south of Fillmore there appear in the bed of the river at Long Beard's Riffs, strata which carry distinctive fossils of the Chemung group, a formation largely of sandstones and sandy shales, which is contained from this point southward to the Pennsylvania line.

The present topography of the river valley and its confines is by no means exclusively excavated in these rock strata.

Superficial accumulations of sand, gravel and clay, forming hills, knolls and terraces are everywhere in evidence, and almost wholly bury from sight the underlying rock strata, leaving us but the faintest conception of the original rock topography of the country. These superficial deposits are by no means haphazard in their distribution. In a general sense, the lower deposits are found to be laminated clays, rising often in beautifully defined terraces skirting the hills on either side, and in some striking instances project-

ing outward in narrow tongues from the hills toward the present channel. The coarser deposits, sand and gravel, usually lie at a higher level.

A moment's reflection will suffice to show that, as clay can be deposited only in quiescent waters, this mantle of clay originally extending across the valley from hill to hill, but only remnants of which are now left to us, implies a large, quiet body of impounded water — in other words, a lake of very considerable extent with a comparatively small outlet, not vastly different in extent to that which, through the construction at the Portage gorge it is now proposed to return. In his geologic report on the Fourth District of New York (1843), Professor James Hall suggested that the drainage of this water may have been, not through the present gorge at Portageville, but to the eastward through a buried valley extending in an almost direct line from Portageville to St. Helena, and thus cutting off the present circuitous bows of the stream. It has also been suggested that the drainage was at one time to the eastward from Portageville to Nunda and through the Canaseraga valley. These are points which can be determined only after the most careful analysis of the changes in the topography of the region and close observation of the distribution of the superficial deposits. The present topography must be looked upon as the outcome of gradually changing sedimentary and erosive forces.

The sand deposits of generally higher elevation than the clays imply a more widely extended body of water. As they cover even the tops of the hills in many places they represent the prevalence of a great lake or very broad water-course of vaster size than that which deposited the underlying clays, and with a strong current which, for the most part, carried off the fine silt and left behind sand and gravel.

It is not germane to our purpose to hear enter into any speculations as to the origin, history or direction of drainage of these successive bodies of water.* The present Genesee river is the depau-

*In a recent paper entitled "Genesee Glacial Lakes" (Bulletin Geological Society of America, Vol. 7, pp. 423-452, April, 1896) Professor H. L. Fairchild has discussed the questions in detail and the reader is referred thereto as the most recent expression on the subject.

perated descendant of these ancient lakes. Strangely enough, but under the most gradual operation of natural laws, it has left its old drainage way and little by little worn down its tortuous course through the rock beds below Portageville. The Portage gorge is unquestionably of very recent geologic age, and the exclusive valley of the present river.

The character of the northern barrier of the broad valley at Portageville should be seriously considered. Before the topography attained its present contour, the hill of sandstone forming the boundary of the opening of the gorge entended across the present channel and was continuous with the rock wall on the east. The eastern end of this ancient rock hill is no longer exposed but is buried under a mass of clay, sand and other alluvium. Its northern exposure seems to be fully faced with rock, but on the side fronting south or toward the proposed reservoir and forming its terminal natural wall, the looser deposits rise in places to the full height of the hill.

Borings into the southern face of this hill, sufficient in number, should determine with precision the distribution of this clay and sand. It seems probable to me, from the observations made, that the sand deposits will be found to lie, to a very large degree, above the reach of the impounded water, and if this is shown by experimental borings to be the case no danger is to be apprehended from the clays beneath.

THE RELATION OF THE TOPOGRAPHY TO THE PROPOSED ELEVATION OF THE WATER-LINE.

I have considered this point with especial reference to the possibility of leakage of the impounded water through minor watercourses now draining into the valley, or of the tapping of the water by similar watercourses passing down the other sides of the watersheds. As the water of the proposed reservoir is not to stand at any place higher than 100 feet and will rapidly decrease in depth to the southward and as the contributory streams are few, and these of very rapid hillside slopes, it seems that no danger can lurk in this possibility, which could not in any event be readily corrected by simple engineering operations.

THE RATE OF EROSION OF THE ROCK IN THE GORGE AT AND BELOW THE DAM SITE.

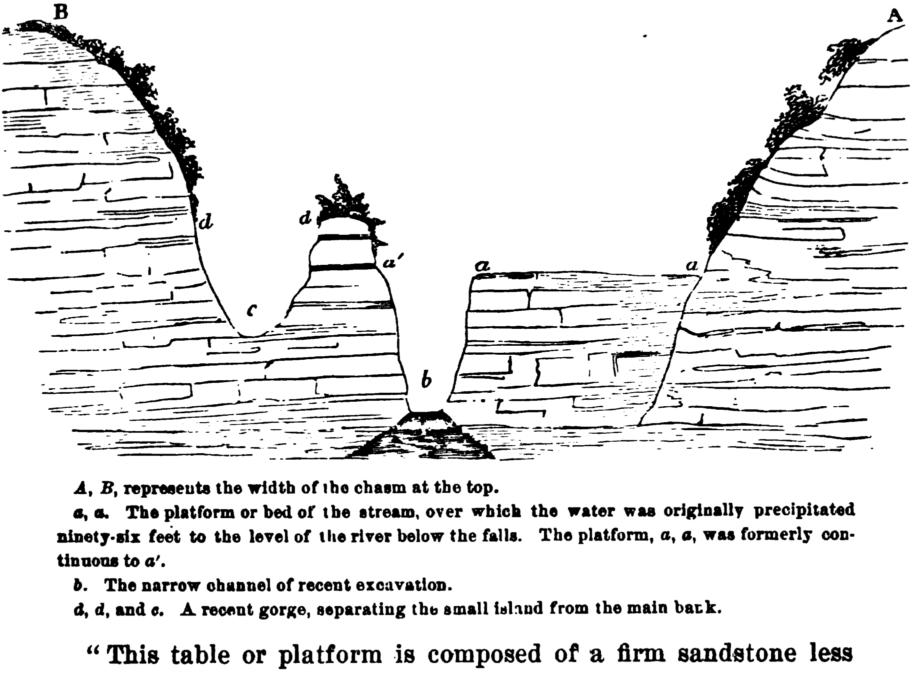
To estimate even rudely the degree to which any watercourse erodes its bed is a problem of extreme difficulty under ordinary conditions. If in a given case, there be a series of historic records representing considerable lapses of time, and which serve to indicate changes in form and contour of objects exposed to the erosive force, such as the shape and position of ox-bows and the form of cascade escarpments, these serve to simplify the problem, by rendering the approximation more justifiable.

Calculations of this nature involving the general erosive and transporting power have been made on some notable large watercourses, such as the Mississippi, the Ganges, the Rhone, etc., but these have been based largely on the consideration of the cubic discharge of the stream and its sedimental contents. From such data an approximate rate of erosion for an entire catchment and drainage basin has been deduced; seldom, however, have satisfactory results been obtained with reference to the current erosive action at any given point in a stream, and never without the aid of historic documents. The power and rate of erosion have nowhere been more carefully studied than at the Niagara Falls; the descriptive and pictorial record of whose variations extends backward through a period of 200 years. Similarly with the Falls of St. Anthony, upon which important calculations have been based.

In considering the rate of erosion through the gorge of the Genesee river below Portageville, and at the three cascades, our records are limited to a map of the Genesee river by Professor E. N. Horsford, published in the annual report of the Geologist of the Fourth district of New York in 1837, and to certain measurements made by Professor James Hall at the Lower Falls and given with illustration in his final report on the Fourth Geological District (1843), fifty-three years ago. In order to compare the observations made at that time with those I have recently made, the remarks made by Professor Hall are here introduced, accompanied by some of the original cuts used with that description (p. 369):* "The sketch at the head of the

* These wood cuts are inserted with the permission of the State Geologist.

chapter represents the lower falls of the Genesee at Portage. The bed of the stream is bounded on either side by cliffs 300 feet high. Upon the left hand is a table of rock which was formerly the river bed; and upon the right is a small conical island of rock, between which and the table on the other side, the stream now flows. Within the memory of the oldest observers, the river flowed almost wholly over this table rock, and the isolated mass was joined with the right bank of the river.* The following diagram will enable the reader fully to comprehend its present and former condition:



A, B, represents the width of the chasm at the top.

a, a. The platform or bed of the stream, over which the water was originally precipitated ninety-six feet to the level of the river below the falls. The platform, *a, a*, was formerly continuous to *a′*.

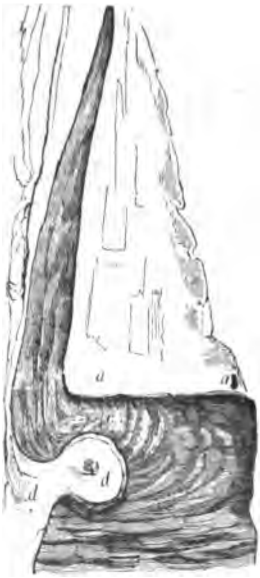
b. The narrow channel of recent excavation.

d, d, and *c*. A recent gorge, separating the small island from the main bank.

"This table or platform is composed of a firm sandstone less than two feet thick, resting on softer strata beneath. A slight depression had been worn between *a′* and *a*. This depression increased in depth by the wearing action of the water and the effects of freezing, so that, long since, the great body of water has flowed through this recent channel. During freshets and at the breaking up of the ice in the spring, the narrow channel on the right is filled, and it then flows over the table above to the depth of a few inches.

*In a foot-note on a subsequent page the author indicates that his authority for this statement is the recollections of Colonel Johnson of Hornby Lodge, who explored this region in 1808, and of Colonel Williams, an early settler.

"The following ground plan of the river at this place will illustrate its condition at the period before the projecting mass of rock was worn through:



a, a. The table, or platform, which originally extended across the whole width of the river's bed.

d, d. An elevated projecting mass of rock, standing in the direct course of the current.

"The first operation by which this change was effected seems to have been a deflection of the current to the right side, caused by a bend in the river above. This force diminished towards the edge of the fall, and the projecting portion of the cliff, *dd,* was thus protected for a long time until the channel on the right side, becoming deepened, drew off nearly all the water in that direction, where it was gradually worn through. When first known the isolated mass was joined to the main cliff; and when subsequently a passage was formed at *c*, the upper part still remained connected with it. This arch was afterwards broken down by the action of freezing water and its own weight, leaving it in its present condition.

"The principal modern effect illustrated in this example, is the formation of the narrow channel on the eastern side of the river bed, which now extends back from the fall about one-eighth of a

mile, being in its greater depth about 80 feet and nearly the same in width. For the whole of this distance it forms a violent rapid, and the action of water and ice is constantly tending to increase its dimensions. Within five years, the period of my own observation, it has been deepened in some places five or six feet, and its southern termination has extended several rods. Except during freshets, or the breaking up of winter, the water does not flow through the channel *c*, of diagram No. 175, and consequently the wearing action has nearly ceased in that direction. The stream, however, is directed against the little island seen in the sketch and will eventually remove it, making for itself a direct channel to the gorge below."

Fifty-three years have elapsed since this description was written; fifty-three spring floods have plunged through this narrow gorge, discharging from 10,000 to 30,000 cubic feet of water per second, intensifying its erosive power with masses of ice and loose blocks of sandstone and shale, and yet to-day there is no feature in which this place has been modified since that time, so far as the above description permits a comparison. The conical island stands as then, its eastern channel apparently no broader or deeper, and its summit still capped with vegetation of no few years' growth. The river in approaching the falls still plunges violently along the narrow channel or flume at the right of its bed, and still beats against the base of the rock-turret; but a half century of this action has not availed to change in any perceptible particular the ground plan of the falls as given by Professor Hall. It is at this very point that the erosive and transporting power of the stream is greater than anywhere else in the entire gorge, on account of the narrow restriction of the stream within the flume, its direct course for a considerable distance and its abrupt deflection just above the falls. Rock masses, in the form of large or small fragments of single strata are doubtless moved or dislodged with each freshet, but we can not find evidence that the entire displacement thus effected in 50 years has materially changed the aspect of the water-course. The great rock platform lying on the left of the channel at the lower falls shows no evidence of diminution of width or

height. The width of the flume on its right accords with that given by Professor Hall. Its height above the base of the falls, on September 3, 1896, with the river moderately high, was 66 feet 8 inches; Hall states that it is 96 feet, and I see no way to account for this discrepancy except to ascribe the latter statement to a typographical mistake. The platform is capped by the identical two foot stratum of sandstone, clean swept over its broad surface, that stood there when the foregoing description and illustrations were made; its distance below the summit of the rock turret is the same and the possibility of the channel of the stream having been filled up 30 feet since that time is very remote.

We have a right to infer from the conditions presented at the Lower Falls that even the spasmodic violence of this stream is not actually producing modifications in contour, of serious moment, nor causing, in any sense, a threatening retreat up-stream of the positions of the cataracts, which would endanger the perpetuity of such a masonry construction as that proposed.

Though we can not, with present data, establish an annual rate of erosion here, we know that from calculations based on the erosive work of other more important water-courses a uniform yearly retreat of one foot would be an extreme maximum; extreme, because improbably high, considering the total annual erosive force and the resistance of the arenargillaceous rocks. One-half foot per year would doubtless be a large maximum retreat, while one-quarter foot would, in my judgment, be a closer approximation to the actual average of maximum retreat. Yet the comparison of the maps of 1837 and 1843 with the present conditions, does not afford evidence of a retreat of the lower falls for 11-12 feet, the result from the assumed rate. The N. Y., L. E. and W. railroad erected its high bridge across the gorge a very short distance above the upper falls in 1876. A year or two thereafter the ledge of rock constituting the top of the falls on the east bank was coated with cement; less, as I am informed, from realization of threatening danger to the structure due to the erosion of the rock, than as a proper precaution against possible risk. This cement cover has

been in place nearly 20 years, and one may observe that in places the rock beneath it and at its edges has in this interval been worn away two, three or four inches.

The distance from the proposed dam site to the Upper Falls is 1,600 feet. If, with the improbable maximum rate of erosion it would take 1,600 years for these falls to reach the dam site, with the probable maximum this period becomes anywhere from 6,400 to 20,000 years.

SUMMARY.

The observations made in the foregoing may be briefly brought together:

The present proposed location of the Genesee dam is upon and between rock strata which compose an altogether dependable foundation. It lies upon a series of sandstones, and sandy shales of several hundred feet in thickness, and containing so little calcareous matter that they are not cavernous nor are they liable to displacements from other causes. Leaving out of consideration the superiority of results to be obtained in the amount of water impounded by such a dam, it is safely said that, with reference to the rock foundation alone, the site at Portage is far superior to those which have been previously contemplated, further down the river, and is the most advantageous position for such a structure that this river affords in its entire length.

The natural walls of the reservoir are, in the main, those of an ancient lake of considerably greater extent. They are not altogether naked rock walls, but are in part drift and alluvium-covered rock ridges, or terraces of tenacious clay. They served nature as impounding walls for countless years; doubtless they will serve the State of New York quite as efficiently.

There is no apparent danger to the integrity of the reservoir from leakage through its natural walls, or from stream tapping from adjacent watersheds.

Notwithstanding the somewhat violent displacement of small rock masses through the Portage gorge at times of freshet, the

immense discharge of water and considerable detrition of the rock beds at these times, we find that these apparent effects are somewhat illusory, that the actual annual retreat southward of any of the cataracts is exceedingly slight and affords no possible ground of apprehension for the stability of a structure so remote from the scene of this spasmodic, if intense, action.

Respectfully yours,

JOHN M. CLARKE.

Albany, October 1, 1896.

High Masonry Dams in Europe.

As stated in the body of the report, the storage of water for the use of the enlarged Erie canal and for power purposes is now attracting considerable attention in this State, and, while we have, in the high dams of the Croton water-works, as fine examples as can be found anywhere, still, it is considered that a brief account of some of the high dams of Europe, which were visited by the writer in the fall of 1894, will not be inopportune at this time. The following account, therefore, of the high masonry dams at Saint-Etienne, Lake Vyrnwy and Lake Thurlmere, is offered as a very slight contribution to the general stock of information in regard to such dams.

THREE TYPES OF DAM DESCRIBED.

The dams herein described represent three different types, and, in a general way, embody, with one exception, the methods of construction of masonry dams thus far successfully used in various parts of the world. Of these several types we have first, the Saint-Etienne dam, built entirely of small stones such as one or two men can easily handle. According to the French engineers, this type of dam is preferable, because of greater certainty of making absolutely water-tight work by liberal use of the cement mortar, although it appears evident that the stability must depend largely upon the strength of the mortar as well as its adhesion to the stones. There can be very little certainty of thorough bond with such small stones. The second type is illustrated by the Vyrnwy dam, where the opposite of the French view has been followed. The dam is built throughout of stone as large as could be handled by powerful machinery. In the lower portions of the dam about one-third of the stone weighed from four to eight gross tons;

twenty-one per cent. weighed from two to four tons and only forty-six per cent. were under two tons weight. These large stones were first firmly bedded by pounding, and smaller stones then filled in between the larger ones, with the interstices finally filled with fine concrete rammed home with blunt swords. The third type of construction is that used at the Lake Thurlmere dam, where the heart of the dam is of concrete, with large stones bedded therein, while the faces are of blockwork, as shown by the photographs.

The fourth type of dam, not here illustrated, is built entirely of concrete. An excellent example of this type may be found in the San Mateo dam of the San Francisco water-works, in this country. Other examples of this type may be mentioned, but as this particular kind of dam is not now under discussion, extended reference to concrete dams is for the present omitted.

THE DAM OF ROCHETAILLE, ON THE FURENS RIVER.

The dam near Saint-Etienne, across the Furens river at the "Gouffre d'Enfer," is frequently referred to as the Furens dam, as well as the dam of Rochetaillée, from the name of an ancient village near its site.

Saint-Etienne is a manufacturing town situated in the Department of the Loire, about thirty-six miles from Lyons, and with a population in 1895 of 150,000, although in 1832 the population was only about 30,000. It is the chief seat of the ribbon trade of France, the principal manufacturing establishments of the city being devoted to that specialty. The country thereabouts is mountainous and the Furens river, which traverses the entire city, is ordinarily a small stream, but when swollen with rain it becomes a mountain torrent. A particularly severe flood occurred in 1849, which, even though the city was much smaller then than now, was still the source of heavy damage.

According to the computations of Mr. Graeff, who was at that time chief engineer of the Department of the Loire, the flow of the Furens river at the great flood of 1849 was at least 131 cubic metres per second (4,625 cubic feet per second), and an overflow of the banks begins when the stream rises to a flow of 93 cubic meters per second (3,283 cubic feet per second). It was necessary,

then, in order to prevent the floods, that a storage be made of such capacity as to insure holding the stream, under the most adverse circumstances, at a flow somewhat less than 93 cubic meters per second. Several severe floods having occurred within a period of a few years, a project authorizing the construction of such a storage was adopted in 1858. The site selected for the regulating dam was a narrow rocky gorge on the Furens river, known as the "Gouffre d'Enfer," where the bottom width is not more than 15 metres (49.7 feet). See Plate XLVII, for view of this gorge, from below the dam.

The objects to be attained by this construction were three-fold:

(1.) The protection of the city of Saint-Etienne from the floods to which it was periodically exposed.

(2.) To furnish a water supply to the city of Saint-Etienne.

(3.) To assist the low water flow of the stream for the benefit of the large number of manufacturing establishments, operated by water power, which are located along the Furens river, and which from their number, following one another in rapid succession, must constitute an important source of the productive wealth of the valley.

The distance from the centre of the city to the dam is about 10 kilometers (6.26 miles) and the manufacturing establishments are spread over nearly the whole extent to not far below the dam.

The tributary drainage area above the dam is about 2,500 hectares (9.5 square miles), and the mean rainfall about one meter a year (39.4 inches). The storage effected by the dam is 1,600,000 cubic meters (56,350,000 cubic feet).

It is clear from the preceding statistics of drainage area and storage that so far as quantity of water involved is concerned there is very little about this dam of interest to American engineers, and, if there were not other considerations, it would hardly be worth while to leave the beaten line of travel to visit it.

The real interest, however, is found in the great height of 56 meters (183.7 feet) of the Furens dam, as well as the fact that it was the first dam to be built on the modern economic profile. These two points make it well worthy of study by any one interested in high dams.

PUBLIC PARK AT SAINT-ETIENNE.

In visiting the Furens dam the surroundings are worthy of momentary consideration as well as the dam itself. The drive from Saint-Etienne through a well made road winding along the side of the valley with the picturesque village of Rochetaillée and its ancient chateau perched on the cliffs to the left is a fine introduction to the rugged Gouffre d'Enfer, where rock needles rise far above the narrow valley across which the dam is thrown. The area for some distance down the valley from the dam, as well as the sides of the reservoir have been appropriated by the city of Saint-Etienne as a public park and tastefully laid out with such winding roads and paths as the nature of the ground will permit of. Plates XLVII and L, show the front of the dam, with the stone steps by which the ascent is made from the bottom to the top appearing on the left, while Plate XLVIII, taken from above the dam, shows the village of Rochetaillée in the distance. The people of Saint-Etienne are exceedingly proud of their park and all the roads, paths, and other artificial features are permanently constructed.

As already noted, and as may be easily gathered from the photographic views, the gorge to be closed is quite narrow, only about 100 meters (328 feet) wide across the top of the dam, and it was, therefore, decided to make the dam curved in plan, with a radius of 252.5 meters (828.4 feet). The curved form is well shown by Plates L and LI. Plate LI, also shows the passageway across the top of the dam as well as the benching of the masonry near the top.

The Furens dam was completed in 1866. Its profile, as shown by Fig. 1, was a radical departure from all previous existing types. Inasmuch as the author has referred extensively to the literature of high masonry dams in another paper,* and the object now is chiefly to jot down personal observations, we will leave this part of the subject with the single remark that the papers of Messrs. Graeff and Delocre, the designing engineers of the dam, in the Annales des Ponts et Chaussées for September and October, 1866.

*Notes on the Design and Construction of Masonry Dams. By Geo. W. Rafter. Transactions of the Association of Civil Engineers of Cornell University, Vol. III, 1895.

and of Mr. Montgolfier, the constructing engineer, in the same publication for 1875, furnish such full descriptions of every detail of the design, as well as the method of computation adopted, as to render further reference under these heads unnecessary in this place, where the space can be better used in discussing points not specifically referred to in other publications.

The several memoirs lay special stress on the care used in construction and the author was, therefore, considerably interested to observe some evidence of leakage at the ends, due apparently to lack of thorough joining of the masonry to the original rock. The masonry itself, so far as could be determined, appeared to be water tight, although there was some moisture on the down stream face which could, however, be explained by the high degree of humidity at the date of the visit. The leakage at the ends was, so far as discoverable, mostly high up, and may be due to the fact that above a height of 15 meters (49 feet) common cement was used instead of the superior Vassey which was liberally applied in the foundation. On the other hand, the water at the time of the author's visit in December, 1894, stood at about the elevation shown in Plate XLIX, from which it was inferred that the leakage may be considerably more than then appeared, when the reservoir is full.

QUALITY OF THE STONE USED.

According to the memoirs, and as appears from inspection, the stone, which were taken from the excavations for the foundation and from the new channel of the river, as well as from neighboring quarries, were from two to seven cubic feet in volume. In order to facilitate repairs cut stone corbels were built out on the front in regular order, as shown in Plate XLVII. The quality of the masonry, so far as it can be seen on the face, is well shown by Plates XLIX and XLI. The masonry cost 15 francs ($3.00 approximately) per cubic meter (35.3 cubic feet) or $2.30 per cubic yard.

The total quantity of rubble masonry is stated at 45,000 cubic meters (58,830 cubic yards), while the cost of impounding the water was 1.15 francs per cubic meter ($6,200 per million cubic feet).

The cost of the completed reservoir is given at 1,590,000 francs ($310,000), of which sum the city of Saint-Etienne, in consideration of receiving its water supply and other benefits, paid nearly two-thirds, the balance being paid by the Department of the Loire.

BARRAGE DE PAS DU RIOT.

In 1872-78 the water supply of the growing city of Saint-Etienne having proved inadequate, another dam, known as the Barrage de Pas du Riot, was constructed on the Furens river about one and one-half miles above the dam of Rochetaillée. This dam is 34.5 meters high (113.2 feet), and also curved in plan. Its profile was based on that of the dam of Rochetaillée. The storage afforded is 1,300,000 cubic metres (45,877,000 cubic feet).

The path leading between the two dams passes through most interesting scenery, of which an idea may be gained from Plates XLVII and LII. To the author these paths and roads possessed an additional interest, as illustrating how thoroughly the progressive authorities of Saint-Etienne had utilized these great works of utility as public pleasure grounds for the people.

It was learned that on Sundays and holidays during the summer, conveyance from the city to the park and return was placed at a very low rate, so that even a working girl in the great ribbon factories might, if she wished, enjoy the fresh air and incomparable scenery of the Furens valley and the Gouffre d'Enfer.

ARRANGEMENTS FOR DISCHARGING SURPLUS WATERS.

Perhaps as interesting a feature of this work as any is the means employed to dispose of the surplus waters of the Furens river in time of flood flow or at any time when the reservoir is completely full and the flow of the stream must of necessity be passed on to the valley below. This is accomplished by a new channel along one side of the reservoir, as shown on the left in Plate XLVII. An overflow from the reservoir into this side channel is also seen just over the left end of the dam in Plate XLVII. The artificial channel extends to the head of the reservoir, where are masonry regulating works, shown by Plate LII, which permit of turning the

flow of the stream either into the reservoir or into the side channel or a certain proportion into each at the same time. These head works are substantially constructed of masonry and extend entirely across the valley, as shown in the plate.

In addition to the artificial channel, water is or may be discharged from the reservoir by two tunnels at different levels, the gate house of the upper one being shown at the right in Plates XLVIII and XLIX.

Taking into account the marked departure in its profile from previously existing types, and its great height, as well as the thoroughness with which not only the works of utility, but those for the public pleasure have been carried out, we must consider the "grand barrage de Rochetaillée" as one of the great works of this century, creditable alike to the eminent engineers who designed and successfully executed it, as well as to the public spirit of the city of Saint-Etienne, whose money was chiefly expended.

THE VYRNWY DAM OF THE LIVERPOOL WATER-WORKS.

The dam of the Liverpool water-works at Lake Vyrnwy, Wales, is the antithesis of that on the Furens river at Saint-Etienne in nearly every particular. The Vyrnwy river flowed through a broad alluvial valley, which could only be barred by a wall with deep foundation and of considerable length. The quality of the building stone of the vicinity was such as to permit of the use of massive rubble, while at the Furens dam the stone came naturally to hand in small blocks, a fact which undoubtedly largely determined the character of the masonry at that place. Again, the Vyrnwy dam is designed with reference to discharge of the flood flows directly over the face of the dam, as shown in Plate LVI, while at the Furens dam the flood flows are discharged through the artificial channel and the by-wash. Plate LIII shows the site of the Vyrnwy lake in its natural state, Plate LIV the valley after the construction of the dam and before filling with water, while Plate LV is a general view of the dam and artificial lake created thereby.

The Vyrnwy dam was completed in 1891, at a cost of £742,379 ($3,593,114). This sum includes, however, the land damages as

well as the purchase of about 12,000 acres of the tributary watershed. It also includes the cost of the elegant wagon road around the lake, to be referred to further on, but does not include the straining tower. The object of its construction was to provide an additional water supply for the city of Liverpool, which is distant something like 68 miles.

LOCATION.

The Vyrnwy lake is situated in the county of Montgomery in North Wales, in a remote and unfrequented part of the Principality. The nearest railway station is Llanfyllin, about 10 miles from the dam. This place may be reached by way of Oswestry from Shrewsbury and Birmingham to the east, and from Chester and Liverpool to the north.

WATERSHED STATISTICS.

The Vyrnwy river has a drainage area above the dam of 18,000 acres (28.13 square miles). In addition the Liverpool Corporation have authority, under the Act of Parliament authorizing the construction of the works, to divert two neighboring streams, with an area of 5,200 acres (8.13 square miles), so that when all the works contemplated by the Act of Parliament have been carried out, the total tributary watershed will be 23,200 acres (36.25 square miles).

RAINFALL.

The rainfall varies from about 50 inches per year to 119 inches, as determined from the extremes of several rain gages which have been kept in different parts of the Vyrnwy valley for many years.

THE REQUIREMENTS OF THE RIVER SEVERN CONSERVANCY COMMISSIONERS.

The Conservancy Commissioners of the River Severn opposed the Act of Parliament authorizing these works, on the ground that the low water flow of the stream would be decreased to the injury of the navigation and fisheries in the Severn, and in order to meet their objections, the Act provides that compensation water shall

be furnished to the extent of 10,000,000 Imperial gallons per day, although the low water flow of the stream was only about 2,000,000 Imperial gallons per day previous to the construction of the Vyrnwy lake. In addition to this daily unintermittent supply of 10,000,000 gallons, the Liverpool Corporation have further to deliver 1,200,000,000 Imperial gallons every year in the form of freshets of 40,000,000 gallons each, at such times as the Severn Conservancy Commissioners may require. This condition involved raising the dam five feet higher than originally intended and added considerably to the cost. These freshets are assumed to be beneficial in connection with the breeding of fish and the scouring of the Severn.

The additional water supply for the city of Liverpool was placed at 40,000,000 Imperial gallons per day.

These several requirements indicated a necessary height of dam, in order to obtain the required storage capacity, of 84 feet above the river bed; or a height of 144 feet above the rock foundation on which the masonry rests. As shown by the illustrations, a roadway is carried across the top of the dam proper on arches, the parapet of which is 161 feet above the foundations.

The actual storage provided by this massive structure is 13,125,000,000 Imperial gallons (2,103,000,000 cubic feet). The cost per million cubic feet stored becomes, then, $1,708.56.

The area of the lake is 1,121 acres and its length 4.75 miles.

DISCHARGE OF SURPLUS WATER OVER FACE OF DAM.

A special feature of this dam which distinguishes it from nearly all other high masonry dams thus far constructed, is the spillway directly over the front face, instead of by an independent by-wash or waste-weir as at the Furens dam. In order to provide for the shock of the falling water it was deemed necessary to materially modify the profile from the theoretical requirements of a wall to stand the pressure of the given head of water. Figure 2 illustrates the profile actually adopted with the diagram of pressure exhibited thereon; while Figure 3 compares this actual profile with the theoretical.

QUALITY OF STONE.

The stone used in the consideration is a hard, slaty, dark gray stone difficult and expensive to work and belonging to the Caradac group of the Lower Silurian. It was obtained from a quarry about a mile and a quarter to the north. The difficulty of working this stone, as well as the fact of its quarrying more conveniently in large blocks, has undoubtedly largely determined the cyclopean character of the masonry of this dam. A good idea of the character of the masonry may be gathered from Plate LVII, which also illustrates the depth to which the foundations were carried below the bottom of the valley, as well as into the hillsides at the end. Figures 4, 5 and 6, also show the quality of the masonry above water level on the dam stream face.*

DISCHARGE TUNNELS.

Figures 4 and 5 further show the lower ends of the tunnels through which the discharge pipes are laid. These tunnels are 15 feet in diameter and 70 feet in length. During construction they served to discharge the flow of the stream, but are now stopped at the upper end by a thickness of 18 feet of brickwork, in which pipes controlled by valves are built. As shown by Fig. 16, these valves are controlled by spindles carried up to valve chambers built in the interior of the dam above, and accessible either from below or by passageways and by spiral stairways built in the interior of the dam itself. In the northeastern tunnel there is one pipe 39 inches in diameter, and the southwestern two pipes, one of 30 inches diameter, the other of 18 inches in diameter. Figure 7 shows the upstream end of one of these tunnels as it appeared during construction and before insertion of discharge pipes and brickwork.

The 18-inch pipe is utilized to discharge the daily compensation water of 10,000,000 gallons to the river, and the 30-inch for the 40,000,000 gallon freshets before referred to.

*For detail of the construction of the masonry see Mr. Deacon's paper on the Vyrnwy works for the Water Supply of Liverpool, Proc. Inst. C. E. Vol. CXXVI. Sessions 1895-96. Part VI, pp. 26-127. The remarks as to the use of concrete between the large stones both in the paper and in the discussion are of great value.

To the right of the centre in Figure 5 the gage house is seen. The 18-inch discharge pipe leads into this building where there are placed arrangements for verifying the quantity flowing. The freshet flows are designed to be measured by the thin-edged rectangular orifices in metallic plates to be seen in front of the tunnel in Figures 4 and 5.*

The Severn Commissioners attach so much importance to the compensation water that they employ a resident inspector, whose sole duty is to see that the provisions of the Act of Parliament are faithfully observed.

GAGING APPARATUS.

In addition to the apparatus for measuring accurately the daily compensation water and the freshet flows, the Liverpool Corporation have arranged to keep an accurate record of the entire daily outflow of the lake. In order to catch any possible leakage, as well as the overflow in times of high water, it was necessary to locate a measuring weir below the compensation gages. This weir, with its gage house at the left, is shown by Plate LVIII. The depth on the weir is here recorded by automatic arrangements, thus insuring a continuous and accurate record. The outflow through the waterworks conduit is measured at another point.

There are 31 of the arched openings under the roadway for the discharge of surplus flood waters, but usually only the 19 openings between the towers are allowed to act, the balance being partly closed with flashboards. Figure 8 is a view of the upper side of these passageways, showing the flashboards in place. Referring to Plate LVI, it will be observed that at the time of making that photograph the openings to the side of the towers must have been closed. In Figure 6 we have a view of the gutter at the end of the dam designed to protect the bank from erosion should it ever become necessary in some great flood to use the side openings either to partial or full capacity.

---

*See remarks on this part of the design by Mr. Deacon in the discussion before the Institution of Civil Engineers. Proc. Vol. CXXVI, Pt. IV, p. 43.

ARCHITECTURAL ADORNMENT AND ROADS ABOUT RESERVOIR.

Nothing strikes one with more force about these works than the large sums expended in securing architectural effects and in improving the surroundings. The artistic inlet tower, as shown by Plate LXIX, is a striking illustration of this remark. The road across the top of the dam illustrated by Figure 9, and the new road, nearly 12 miles in length, completely encircling the lake are in the same line. This road illustrated by Plates LX, LXI, LXII and LXIII is from 20 to 30 feet in width and has been cut in the side hill at an average of about 30 feet above the flow line. Plate LXIV illustrates a bridge on this road at the head of the lake.

Since there were no adequate accommodations for transient visitors in this out of the way region, the Liverpool Corporation have further erected a comfortable hotel, in a commanding position near the lake, as shown in the upper left hand portion of Figure 9. The monument erected by the corporation to the memory of employes killed by accident, or who died from natural causes during the progress of the work, is also seen a little to the left of the upper center of Figure 9.

REGULATIONS FOR FISHING.

Previous to the construction of this great storage reservoir the Vyrnwy river was famous fishing ground, and, as there was no reason for supposing the construction of the dam would in any way injure the stream in this particular, the corporation established regulations under which fishing would be still permitted in Lake Vyrnwy. The regulations provide (1) that all fishing shall be with artificial fly only, no minnows, worms or other lure being allowed; (2) no trout taken from the lake to be retained if less than 10 inches long; (3) trout taken from the tributary streams not to be retained if less than 6 inches long; (4) no wading in the lake; (5) no fishing before 6 a. m. or later than one-half hour after sunset; (6) no Sunday fishing; (7) no attendant to fish.

The rules also provide that the season shall commence on March 26, and close on a date in September to be duly announced, except

that for coarse fish there shall be no close time, and anglers are requested to kill such when taken. Fishing tickets must be procured at the Lake Vyrnwy Hotel, and baskets are numbered and weighed at the hotel on the conclusion of each day's fishing.

It is by the enforcement of the regulations governing the admission of compensation water to the lower river and by these rules relating to fishing in the lake and its tributaries, that all the parties in interest expect to maintain and improve the fishing capabilities of the stream from year to year.

The engineer of the Vyrnwy dam and works was George F. Deacon, M. Inst. C. E., at that time chief engineer of the Liverpool Water-Works.*

THE LAKE THURLMERE DAM OF THE MANCHESTER WATER-WORKS.

At Lake Thurlmere, in the famous lake region of Cumberland, we have the new dam of the Manchester Corporation additional water supply works, as completed in 1893. The nearest railway station is Threlkeld, although the most convenient place from which to reach the lake is Keswick, distant about five miles. The lake in its natural condition is about two and three-quarters miles long and varies considerably in width. The present area is 330 acres, but as the enabling Act of Parliament provides that the lake shall not be drawn below its present level, it is intended to ultimately raise it 50 feet, when the area will become 793 acres.

DRAINAGE AREA AND RAINFALL.

The drainage area of the lake proper is 7,400 acres, but the Manchester Corporation are permitted to divert an adjacent area of 3,600 acres, thus giving a final total of 11,000 acres (17.19 square miles).

The rainfall in an ordinary year varies from about 137 inches on the west of the valley of the lake, to about 100 inches in the val-

*For an account of the Lake Vyrnwy dam with plans, sections, etc., see the Engineer for July 15, 1892. (Supplement.) Also see paper on the Vyrnwy Works for the Water Supply of Liverpool. By Geo. F. Deacon, in the Proc. Inst. C. E. Vol. CXXVI (Session 1895-96) Part IV.

ley; while in dry years the range is from 80 inches to 60 inches in the same places. The hills are so steep and the rock so near or actually on the surface, that the evaporation and absorption are exceedingly small, and the water is accordingly delivered into the lake in a state of great natural purity. These circumstances also occasion enormous floods. Rainfalls of from four to five inches in a day are not uncommon, and as this nearly all runs off as soon as fallen the whole country has at times the appearance of being flooded. Every gorge and gully sends down, from hundreds of feet above, its quantum of water. Several of these streams may be seen in the background of Plates LXX and LXVI, which are general views of the dam from two different positions.

COMPENSATION WATER TO THE STREAM.

As at Lake Vyrnwy, the enabling Act provided for passing a certain amount of compensation water to St. John's beck, the stream issuing from Lake Thurlmere. For the present it is only contemplated to raise the lake surface 20 feet, and the compensation water during the period of 20 feet raise is limited to 4,126,125 Imperial gallons per day; but when fully raised to 50 feet, the compensation water must be delivered at rate of 5,520,487 Imperial gallons per day. The supply to be diverted ultimately for the use of the city of Manchester has been placed at 50,000,000 gallons per day, and the full capacity of the storage for 50 feet raise is computed at 8,135,000,000 gallons. This capacity is equal to a rainfall of about 33 inches over the drainage area, and to that extent is available to supplement the rainfall of dry years.

The distance to Manchester along the line of the aqueduct is about 96 miles.

REASONS FOR CURVED PLAN AT THE THURLMERE DAM.

As shown by Plates LXV and LXVI, the dam is built on a reverse curve, but this has not been done to gain additional strength, as might be supposed, but because the borings revealed the existence of a ledge of rock on the line selected, by following which a large amount of work has been saved.

DESCRIPTION OF THE GAGE BASIN.

At about the middle of the dam, at the point where the valve house for the compensation water is situated, as shown at the left of the center in Plate LXV, there is a small rocky hill through which a tunnel was driven for use as a by-wash during construction, and through which an 18-inch pipe has been laid to the gage basin for compensation water, as shown on Plate LXVII. Figure 10 is a closer view of the gage basin, showing the water discharging through the rectangular weir orifices in the sides. This gage basin is also provided with a compartment at one side, of known dimensions, into which, by manipulating valves, the compensation water may be turned and the rate of discharge determined by an observation of the time required to fill the basin. In this way the non-technical Conservancy Commissioners may at any time satisfy themselves that the statutory quantity is passing. This chamber is shown in the left half of the basin on Plate LXVII.

At the west end of the dam an overflow swallow has been formed with its crest, as shown in Plate LXVIII, at the flow line for 50 feet raise. This overflow connects with a tunnel whereby the water is delivered to an old waste water-course, by which it flows to St. John's beck at the gage basin. There is also a heading connecting with the lake at the 20 feet level, through which the surplus water was discharging at the time of the author's visit in October, 1894. The down stream portal of this discharge tunnel is shown by Figure 11. Leading from the mouth of the discharge tunnel is the wasteway with vertical side walls and paved and concrete bottom, as shown in Plate LXIX.

GENERAL DIMENSIONS OF THE THURLMERE DAM.

The dam is 857 feet long, with a section as shown in Figures 12 and 15. Its top is 6.2 feet above the level of the lake when fully raised, and the top width over all 18.5 feet. The excavations were carried deep enough to insure water-tight work, which gives a maximum height above the foundation at one place of 104.5 feet. Along the inner toe a trench 6 feet wide and from 4 to 9 feet deep was sunk below the main foundation and filled with concrete.

THE QUALITY OF THE STONE.

We have seen in the case of the dam at Saint-Etienne and at Lake Vyrnwy how the exigencies of the local material have influenced the method of construction adopted. The Lake Thurlmere dam is no exception to the others in this particular. The local stone, a bluish, slaty rock, is easily shattered in dressing, and from its fragile character somewhat liable to break if exposed to direct frost action. It was therefore decided to make the downstream face of the dam of the new red sandstone from Dumfriesbire, and the inner face, next to the water, of a still harder sandstone, from Longridge quarry, near Preston. The interior of the dam is built up of concrete formed of the local stone. The concrete was laid in layers of from 9 to 12 inches thick, and large single stones locally called "plums," put in as close as would conveniently allow of working the concrete between them. The difference between the use of the concrete here and at the Vyrnwy dam is quite distinct, as there the local stones were placed as close as possible, and fine concrete rammed into the interstices, while at the Thurlmere dam the plums were merely irregularly disposed with ample space between. In the one case we have a stone wall in which the stones themselves form a bond with concrete largely used in the interstices instead of mortar; while in the other case we have a concrete wall with large stones added, presumably, to give additional weight and mass.

Figures 13 and 14 show the quality of the masonry on the downstream or outer face of the dam, which, as will be seen, is block-in-course; while Plate LXX shows the coursed, harder ashler masonry of the inner face.

WAGON ROADS ABOUT LAKE THURLMERE.

Roads have been constructed about Lake Thurlmere where they were wanting, the same as at Lake Vyrnwy, and add greatly to the attractiveness of a region which has been famous for its scenery from time immemorial.

The engineer of the Thurlmere dam and other additional water supply works was George H. Hill, M. Inst. C. E., of Manchester.*

*For an account of the Thurlmere dam in detail, with maps, plans and sections, see Engineering, Vol. LII, 1891, pp. 485 and 495. Also see paper on the Thurlmere Works for the Water Supply of Manchester in Trans. Inst. C. E. Vol. CXXVI (Session 1895-96) Part IV.

CONCLUSIONS.

Perhaps the most impressive thing about all these great foreign works is the minute care exercised to insure permanent construction in every particular. From this point of view we have still much to learn from the foreign engineers.

The disposition to spend something on mere decoration in the three works here briefly described is also encouraging as to the possible complete union of the utilitarian and the aesthetic at some period in the future.

The rational use of the local material in the best manner available, as exemplified in the construction of these dams, may also serve to illustrate the importance of working each project out on its merits without special reference to what has been done elsewhere.*

GEO. W. RAFTER.

*The photographic illustrations to the foregoing report have been derived as follows: Plates I and II, from photographs by Mr. Charles Streb of Rochester. Plates III to IX, inclusive are from a series of photographs of the 1865 flood now in the possession of the Rochester Historical Society. Several of the negatives were made by Monroe, a former photographer of Rochester but whether all were by him is unknown. Plate X, By Mr. Streb. Plate XI, by James Lennon of Mount Morris; Plate XII by S. E. Wright of Mount Morris; Plate XIII by the Rochester Photographic Company; Plates XIV to XVII by Peter Mawdsley; Plate XXII by Mr. Streb; Plates XXIII and XXIV by Mr. Mawdsley; Plates XXV to LII, by Bellotti, a photographer of Saint-Etienne, France; Plates LIII to LVIII, by Robinson and Thompson, photographers of Liverpool; Plate LVIII by Mr. Rafter; Plates LIX to LXIV, by Robinson and Thompson; Plates LXV to LXX by Mr. Rafter. Fig. 7 is by Robinson and Thompson, and the balance of the photographic figures by Mr. Rafter.

1897.

NEW YORK STATE CANALS.

Specification Governing the Construction of the Masonry Dam on the Genesee River at Portage.

General Description.— The work to be done under this specification includes the clearing and grubbing of the site of the Portage dam, the excavating of the foundation, furnishing of the materials and the construction of the dam in accordance with the plans. The dam is to be erected across the Genesee river gorge at a point about 1,200 feet southerly from the Erie railway viaduct, at the brink of the upper Portage fall. The specific location may be determined by reference to the plans. The face of the dam is to be built of sandstone of a quality satisfactory to the State Engineer and Surveyor. The interior of the dam will be made either of rubble stone masonry or of concrete, as may be determined by the State Engineer and Surveyor. The dam will have four discharge tunnels, each 14 feet in diameter at the smallest section, extending entirely through it for the purpose of discharging the ordinary flood flows of the stream during construction, and also for the purpose of affording convenient passages for the discharge of water permanently after the dam is completed. These discharge tunnels are to be built in pairs at each side of the present river channel, as shown on plans. In order to compensate for the material taken out of the cross-section by these tunnels, the dam is buttressed over the discharge tunnels, as shown on the plans, with buttresses surmounted by ornamental towers. The gate house is situated on the back side of the dam, midway between the discharge tunnels. At each side of the river the natural rock is to be

excavated and two spillways, each about 365 feet in length, constructed. The water discharged over these spillways is to be conducted to the bed of the river below the dam by means of a by-wash channel excavated in the rock with retaining walls next to the dam, as shown. Retaining walls will also be built for supporting the wagon road, as shown on the plans.

The foundation of the dam will be made on the solid rock in the river bed and carried to substantially the depth shown on the plans, or, in case the engineer should judge either a greater or a less depth necessary, in that case carried to such depth as the engineer may specifically direct. All cracks, seams and openings will be closed with Portland cement grout. Also, as required, holes will be drilled in the foundation and Portland cement pumped therein under pressure. In any case, the concrete trench just within the inner face of the dam will be treated in this manner.

In order to control the flow of the river during the excavating of the foundation and the laying of the foundation masonry, the contractor will be required to construct a coffer-dam turning the river to one-side of the channel, while the other side is in process. After the masonry of about one-half the distance across the channel has been raised to a short distance above the discharge tunnel, the coffer-dam will be reversed and the water turned through the discharge tunnels already completed at one side, and the foundation at the opposite side then constructed. The discharge tunnels will provide for the ordinary flow and moderate floods, but in heavy freshets, such as the spring flood, they may not be sufficient to discharge the entire flow; the work must, therefore, be carried on at all times with reference to the water overtopping it, and all machinery and appliances arranged with reference to as little injury therefrom as possible. The coffer-dam will be paid for at a price for the material actually used in its construction, which price must include all cost of caring for the flood flows of the river.

The upper portion of the dam will be finished with ornamental courses and with a stone railing, as shown on the plans. A roadway will also be constructed across the top of the dam and the same supported on arches over the by-wash channels leading from

the spillways at each side. The surface of the roadway will be made of asphalt for its entire length over the dam proper as well as the arch bridges at the ends.

The work, not only during its progress, but as finally completed, must conform truly to the lines and levels given by the engineer, and must be built in full accordance with the plans, specifications and directions given by him from time to time, subject to such modifications and conditions as he may deem necessary during the prosecution of the work. In no case will any work which may be performed or any materials furnished in excess of the requirements of this specification, or of the plans, be estimated and paid for unless such excess shall have been ordered by the engineer as herein specified.

The contractor is to furnish all materials, except such as may be obtained from the excavation and all tools, implements, machinery and labor necessary or convenient for doing all work herein provided for with safety to life and property in accordance with this specification and within the contract time. On its completion the work must be in complete working order with all the provisions and instructions of this specification fully complied with. The work must also be to the full satisfaction of the State Engineer and Surveyor, the Superintendent of Public Works and the Engineer in Charge.

The right is reserved under this specification to change not only the location of the dam slightly, but to rearrange its appurtenances at any time before or during the progress of the work, or to any extent which the said engineer may deem expedient. Such changes may include alteration or modifications of the different items of work contemplated to be performed under this specification. The contractor shall not have or make any claim for extra compensation over and above the contract price in consequence of any such changes of location, detail or quantities.

Plans.— The construction plans as on file in the office of the State Engineer and Surveyor, and also at the office of the Superintendent of Public Works, and as exhibited at the time of letting, and numbered A, B, C, D, E, F, etc., show, in a general manner, the type

of the structure to be built under these specifications, as well as the detail so far as necessary for present purposes. They show the location of the work and its general character. During the progress of the work such further working plans will be furnished from time to time by the engineer as he may deem necessary to exhibit the work in all its detail.

Methods and Appliances.— The contractor will use such methods and appliances for the performance of all the operations connected with the work embraced in this specification as will secure a satisfactory quality of work and such rate of progress as will, in the opinion of the engineer, insure the completion of the work within the contract time. If at any time, before the commencement or during the progress of the work, the methods and appliances proposed to be used by the contractor or actually in use shall appear to the engineer insufficient or inappropriate for securing the quality of work required or the said rate of progress, he may order the contractor to increase their efficiency or to improve their character, or both, and the contractor must conform to such order, but a failure on the part of the engineer to demand such increase of efficiency or improvement of methods and appliances shall not release the contractor from his obligation to secure the quality of work and the rate of progress established in these specifications or necessary to complete the work within the contract time.

Test Pits and Borings.— Test pits and borings have been made and the general indications of the plans as to the quality of the excavation to be performed are as per the indications derived therefrom. It is understood, however, that the contractor must take every means and precaution to satisfy himself that such indications are accurate, and, in case when the excavations are actually opened up it turns out otherwise, the contractor shall have no claim for extra compensation from such cause, but shall accept the price bid for the materials of the several qualities specified as full compensation for performing the work whatever it may turn out to be.

Right of Way.— Arrangements for all land necessary for the location of dam as well as the contractor's operations, including roads across the farms and fields from public highways, will be

made by the State authorities and without expense to the contractor, but the contractor will be required to observe strictly all conditions and restrictions that may be incorporated in any easement affecting this work, and will be held responsible for any damage done by him or his employes to any adjoining premises.

Fences.— In order to fully protect life and property the contractor shall erect and maintain suitable fences at his own expense along all roadways and around the grounds occupied by him, such fences to conform in every particular to the directions of the engineer and to the requirements of the easements as aforesaid, and to be removed after the completion of the work. The fences around the dam site proper and the operations connected therewith shall be tight board fences at least eight feet in height, surmounted by barb wire or spikes to prevent scaling. Suitable gates provided with locks and attendants shall be inserted in the said fences. The contractor will not be allowed to admit any person other than employes and officials within the inclosure except on the written order of the engineer.

Lines and Grades.— The contractor shall furnish all labor, tools, appliances, stakes, forms, spikes, timber and material other than engineering assistance and instruments that may be required to enable the engineer to give the necessary lines, grades and levels for the proper construction of the work. All such lines and marks shall be carefully preserved, and if removed through the negligence of the contractor and without the consent of the engineer, the expense of replacing them may be charged to the contractor.

Measurements.— The contractor shall also furnish at all reasonable times all labor, tools, appliances and material of every kind, except engineering assistance and instruments, necessary to enable the engineer to make any inspection test or measurement of the work performed. He shall not make any claim for necessary delay of the work while either lines, grades or levels are being given, or such inspections, tests and measurements are being made.

Clearing and Grubbing.— All trees, stumps, brush, logs, boulders and other obstructions shall be cleared from the site of the dam as well as from the adjacent area, so far as necessary, for the prose-

cution of the work. The extent of the clearing will be determined by the engineer, but in no case shall it extend beyond the limits of any territory controlled by the State, except that the privilege of doing so shall be first obtained by the contractor at his own expense from the proper parties. All fencing material that may be found on the ground will be removed and deposited as the engineer may direct. Fences torn down or injured by the contractor in the prosecution of the work will be rebuilt or made good at his expense and according to the directions of the engineer.

The price paid for clearing and grubbing will be per acre for the actual area cleared and grubbed.

Bailing and Draining.— The contractor will perform all labor and furnish the necessary machinery and appliances for thoroughly bailing and draining the work, including the removal of ice, snow and water, the furnishing of the necessary materials and labor for constructing suitable coffer-dams, as required by the engineer, and also the furnishing and operating of the necessary pumping machinery and appliances for thoroughly draining the work during construction.

Coffer-dams will be constructed of timber and puddle to the satisfaction of the engineer.

All cost of bailing and draining must be included in the entire work except for coffer-dams, for which payment will be made by the M foot board measurement for timber actually used, and for puddle actually used by the cubic yard. The necessary iron work for coffer-dams will be paid for by the pound.

The contractor must also furnish any other labor or material necessary to fully protect the work from injury by water. He will be held responsible for all damage that may be caused by water whether from negligence or any other cause. In case driftwood should collect at the heads of the discharge tunnels the same shall be removed at his own expense, when required by the engineer. At all times during the construction of the dam the work shall be kept in such condition as to suffer as little damage as possible in case of extreme floods overtopping it. Any damage resulting from such cause will be immediately repaired by the contractor.

Western New York and Pennsylvania Railway.— As shown on the plans, the Western New York and Pennsylvania railway now passes through the proposed site of the dam on the east side of the river. It is expected to make, as soon as possible, a new location of the railroad on the west side, but during the time while it is operated by the railroad company at its present location the contractor must make all necessary provisions for protecting passing trains either from obstruction by blasting rock or from other causes. The necessary arrangements are to be made with the railway company for maintaining flagmen at the proper distance each side of the work at the contractor's expense, and all the requirements which the railway company may make for the protection of trains shall be faithfully complied with. Failure to comply with such requirements will be deemed such breach of contract as to give the Superintendent of Public Works the right to vacate the contract if he so elect.

The new location of the railway at the west side of the river will also be exposed somewhat to interruption by reason of the exigencies of the work. After the beginning of the regular operation of the railway on that side the contractor will make the same arrangements as are specified during the period of operation on the east side, with the same penalty as to vacation of contract as provided in the foregoing.

All arrangements as to the furnishing of the necessary sidings and extra appliances on the part of the railway for the delivery of material will be made by the contractor with the railway company and at his own expense, the cost of all such to be included in the whole work.

Stripping, Earth and Loose Rock Excavation.— Under this head will be included all excavation of earth above the rock, as well as the excavation of the old Genesee Valley canal bank on the east side, which probably consists largely of loose rock as cut down from the adjacent rock cliffs at the time of the original construction of that canal. All earth and loose rock excavation will be measured according to the lines and slopes established from time to time by the engineer. The plans indicate in a general way

the slope of the excavation, but they may be modified during construction in accordance with the character of the materials encountered, if, in the opinion of the engineer, such modification is necessary. When so modified the contractor shall conform to the modified lines given from time to time without any extra compensation on account of such modification. The depth at which the earth slopes are to be abandoned and the rock slopes are to be begun will depend entirely on the character of the materials encountered and can not be fixed other than approximately in advance. Any timbering for the support of excavations which may be necessary must be done with great care by skillful mechanics. The excavated material may be deposited in such a manner, at such places and at such distances from the place where excavated as shall be directed or approved by the engineer. Generally speaking, excavated material, either earth or rock, when not needed for use in the work, will be deposited along the sides of the river bank a short distance above the dam. All earth, loose rock, hard pan or other excavated material, including boulders not exceeding one cubic yard each, shall be excavated and estimated as earth and loose rock excavation and paid for at the stipulated price for such excavation.

No extra haul will be paid for material excavated and deposited under this clause of the specification.

The necessary excavation for highways, roads, etc., shall be considered as included under this head.

All earth or loose rock excavation is to be measured in place. No allowance will be made for wet earth or loose rock excavation, but all such work shall be made when required, as though it were dry. In any case the amount of wet earth and loose rock excavation will not exceed a few thousand yards.

Rock Excavation.— Rock excavation will be made for the foundation of the dam in the river bed and at the sides of the gorge, and also for the spillway, by-wash channel, gate house and other necessary appurtenances of the dam to such depths as are shown on the plans, or as may be specifially indicated by the stakes as set out by the engineer during construction. Any rock excavation not specifically enumerated in this place and which the engineer

may order will also be performed. The term rock excavation is intended to include the excavation of all solid rock and of all boulders of more than one cubic yard in size. All rock excavation will be measured in place and on the lines determined by the engineer. In the excavation of the end of the dam, at the side of the gorge, the finished work will be shaped roughly in steps as shown on the plans, or as may be specifically directed by the engineer.

In order to prevent shattering the rock under the foundations and in the cut-off concrete trenches, or at any other places which may be designated by the engineer, the explosives used shall be only of moderate power, properly proportioned in strength to the work to be done, as may be designated by the engineer. Black powder may be ordered to be used by him in special cases. All rock surfaces intended for masonry foundation must be freed from loose pieces and worked down to the firm and solid rock, and prepared as directed by the engineer. Especially shall the foundations be washed clean with jets of water under such pressure as the engineer may deem necessary, before laying any masonry thereon.

All material removed from the rock excavation and not required for the masonry, shall be deposited at such places as may be directed by the engineer. The price bid for rock excavation must include the cost of supporting and maintaining the excavations, of bailing and draining and of disposing of the excavating materials at such places as the engineer may direct, the furnishing of the explosives, tools and appliances of every sort and kind and all other incidental expenses.

Channeling.— In cutting the extreme limit of the rock excavation in the river bed, in order to prevent the shattering of the rock outside of the lines of the work, the exterior limit shall be cut with a channeling machine. Such work shall be done under the direction of the engineer to such depths as he may indicate. It will be paid for at a price per square foot for surface cut, which price must include the furnishing of the channeling machine, power, labor and all expenses of every sort and kind connected with the channeling work.

Timber and Plank in Platforms and for Other Temporary Purposes.— Timber and plank as ordinarily used for platforms and other temporary purposes about the work will not be paid for, but must be considered as included in the whole work, but all such timber and plank shall be of a quality to safely carry any weight to which it may be subjected, and if, in the opinion of the engineer, it is not perfectly safe, it shall be immediately removed and timber and plank to the satisfaction of the engineer substituted. Any timber and plank which may be specifically ordered to be left in the work will be paid for at the same price as for timber and plank in coffer-dam.

Grouting in Foundations.— The contractor will be required to furnish extra fine ground Portland cement for the purposes of grouting all cracks and interstices in the rock of the foundation as required by the engineer. In case the engineer shall consider it necessary, holes shall also be drilled at such distances apart as the engineer may direct, and thin grout forced therein under pressure. In order to prolong the time of the setting of the grout, the engineer may, if in his opinion it is considered desirable so to do, direct the mixing of the Portland cement with fine ground sand. The pressure to be used for forcing the grout into the drill holes shall be from 700 to 800 pounds per square inch. The contractor must furnish the necessary pumping plant, hose, mixing boxes and other appliances for doing this work. The price for the drill holes will be per lineal foot of hole actually drilled, said price to include the furnishing of the drills, power, labor, etc. The price per barrel of the cement must include the furnishing of the pumping plant, mixing boxes, flexible hose and other appliances, as well as the labor of mortar forcing as above specified, and all other expenses connected therewith.

Machinery and Power.— The contractor will furnish all machinery and the power required to drive the same, of whatever kind or nature that may be required for successfully prosecuting the work at the rate required by the specfications and contract, including fuel, labor and all expenditures in connection with the power plant of every sort and kind. The price bid for performing the

whole work must include the furnishing of the power and all appliances whatever they may be. No extra compensation over and above the prices bid will be paid on account of any power or mechanical appliances furnished.

Electric Light Plant.— The contractor will also be required to furnish an electric light plant for working at night, the power for driving the same to be derived, if the contractor so elect, from the Portage falls in the vicinity. The contractor must, however, obtain the necessary concession for the use of power for this purpose from the falls. By way of explaining this clause, it may be stated that it is not the intention of the specifications to permit the laying of masonry at night, but only to provide for the delivery of material upon the work in such manner that the laying of masonry during the working hours of the day may be materially expedited thereby. As regards power from the Portage falls, the contractor may, if he so elect and can obtain the necessary concessions, take all of his power therefrom, the arrangements being made satisfactory to the engineer.

Masonry.— Masonry will be classified as follows: Granite masonry; sandstone rubble face masonry; backing masonry; rubble retaining wall; rubble spillway wall; rubble arch masonry; gate house, tower and railing masonry; brick masonry; concrete masonry.

In every case the masonry shall be laid in American Portland cement mortar, preference being given to the Portland cements manufactured in the State of New York, and shall be built of the forms and dimensions shown on the plans or as directed by the engineer from time to time. All instructions of the engineer in regard to bond of masonry shall be faithfully followed. The joints must be entirely filled with mortar, and the work in all cases well and thoroughly bonded. Care must be taken that no water shall interfere with the proper laying of the masonry, either in the foundation or in any other part of the work. To that end the excavation must be kept perfectly dry by pumping from sumps under direction of the engineer. In case springs should appear at any point in the foundation, such means must be taken to prevent their

interfering with the work as may be deemed necessary by the engineer. In case it is necessary to insert pipes for receiving and leading away the water from springs all such shall be done by the contractor, and the cost thereof included in the whole work. In any case it must be understood that under no circumstances will masonry be allowed to be laid in water.

All necessary iron work as called for by the plans or as ordered by the engineer shall be built into the masonry without other compensation than the price bid per cubic yard of masonry and per pound for the ironwork.

Masonry will not be built in freezing weather except it be so directed by the engineer. In any case, when laying masonry in weather liable to freezing, all newly laid masonry must be covered and protected and appliances furnished and used for heating the water and sand used, and for steaming the stone in a manner satisfactory to the engineer. On the contrary, during the summer season, all newly built masonry shall be kept wet by sprinkling with water until it shall become sufficiently hard, to prevent undue drying and cracking.

Cement.— The cement used must be American Portland cement from manufacturers of established reputation, of a quality satisfactory to the State Engineer and Surveyor, who may establish standards for tests. Or in case the State Engineer and Surveyor shall fail to establish special standards applying to this work the following general provisions will apply: No cement shall be used in any part of the masonry until the State Engineer and Surveyor shall have examined, tested and approved the same. It must be delivered in tight casks or boxes, as the engineer may direct, and thereafter properly protected from the weather. Special directions will be given by the engineer as to the delivery of the cement, and every facility required for securing samples for test must be afforded by the contractor, and no cement used except there be full compliance with these directions. The cement will be sampled by an agent of the State Engineer and Surveyor's department, the said samples to be taken immediately upon delivery of each lot of cement at the site of the work, and contractors will promptly

notify the engineer of the receipt of an invoice of cement in order that no delay may be had in the sampling thereof. Ordinarily, cement must be delivered at the site of the dam as much as one month before it is required for use. If on test it shall appear necessary to the engineer, all such cement must be spread out and exposed to the air, under close shelter, in layers not more than six inches thick, for at least two weeks before being used. If the State Engineer and Surveyor shall so direct the samples will be tested under the direction of the engineer immediately on the work from day to day. Any cement failing in any of the following particulars will be rejected; also the further right is reserved to reject any and all cements the qualities of which are not well known to the State Engineer and Surveyor through prior use in State work or elsewhere. The Portland cement must be of such degree of fineness that 95 per cent. will pass through a sieve of 2,500 meshes in the square inch, and 90 per cent. through a sieve of 10,000 meshes per square inch. When mixed neat and exposed one day in air and six days in water it shall withstand a tensile strain of not less than 400 pounds to the square inch, and when mixed in the ratio of three pounds clean, sharp sand to one pound of cement and exposed one day in air and six days in water it shall withstand a tensile strain of not less than 125 pounds per square inch. Briquettes made of neat cement must not set to the extent of supporting a one-twelfth-inch wire with a quarter of a pound load in less than fifteen minutes. The briquettes of neat cement must not show checks or cracks when immersed in water for seven days after mixing. The cement may also be subjected to a hot test when deemed necessary by the engineer.

In addition to the foregoing tests the engineer may apply such further tests as he may consider desirable. In any case it shall be fully understood by the contractor that the State Engineer and Surveyor reserves the right to apply or to have applied any or all tests of whatever nature may seem to him necessary in order to prove the thorough fitness of the cement offered for the work in hand. Failure on the part of the cement to comply with either the tests already enumerated, or with such other additional tests

as the State Engineer and Surveyor may deem necessary, will be considered sufficient ground for rejection. Any cement rejected will be so branded by the engineer or the inspector acting under his direction, and must be immediately removed from the work to such locality or place as the engineer shall specifically direct. The contractor shall at all times keep in store at some convenient point in the vicinity of the work a sufficient quantity of cement to allow ample time for each and all of the foregoing tests to be made without delay to the work of construction.

Cement will generally be used in the form of mortar with a mixture of sand, and when so used its cost will be included in the cost of the various kinds of masonry. If, however, the engineer should order any quantity of cement used in exceptionally difficult places for grouting seams or for other purposes the cement so used shall be furnished by the contractor, and it will be paid for at a price per barrel of 400 pounds furnished and delivered at the places where it is to be used.

Sand.— The sand to be used in making mortar shall be clean, sharp and free from any considerable mixture of dust, dirt, earth, clay, loam, vegetable mold or other contaminating material. Any sand containing in the aggregate more than from 5 to 8 per cent. of its volume of such impurities will be either rejected or, if the engineer so elect, he may require that it be freed therefrom by washing. For masonry either of stone or brick the sand shall be of such grain that at least 75 per cent. of its volume will pass through a sieve of 400 meshes to the square inch and be retained upon one of 1,600 meshes per square inch. In case the sand contains pebbles in any quantity they shall be removed by proper screening, but if for concrete the sand need not be screened if of a quality otherwise satisfactory to the engineer.

Pointing.— All masonry of whatever character shall be carefully pointed with pointing mortar of the composition specified. To accomplish this the joints shall be raked out to the full depth of at least two inches, washed clean and pointed with pointing mortar thoroughly pounded to its place. In the gate house and other locations where it is important to make absolutely water tight work, the

pointing may, if so required by the engineer, be made with nearly dry, neat Portland cement rammed to place. In any case pointing shall be neatly finished to a line on the face. The cost of all pointing, including the furnishing of the cement, mortar, labor and tools shall be included in the several prices bid for masonry. If the engineer should at any time become satisfied that the pointing of any portion of the work has not been properly made he may require that all such work be taken out and the pointing made over again.

Mortar.— All mortar shall be prepared from American Portland cement in perfect condition and from clean sand, as specified in the foregoing, thoroughly mixed together dry, in the following proportions by measure: For granite masonry and for rubble sandstone masonry in the faces of the dam, two parts of sand to one of cement; for backing masonry in the interior of the dam, three parts of sand to one of cement; for spillway wall rubble masonry, two parts of sand to one of cement; for rubble arch masonry, three parts of sand to one of cement; for gate house, tower and railing masonry, three parts of sand to one of cement; for brick masonry, two parts of sand to one of cement; for concrete masonry, three parts of sand to one of cement; for pointing, one and one-half parts of sand to one of cement.

In case sand of an inferior quality is furnished, the engineer shall have the right to reduce the proportion of such sand in the proportion of the mortar to such a degree as shall, in his opinion, compensate for the deficiency in quality of sand, such reduction to be made without claim for extra compensation on the part of the contractor. Generally the sand and cement must always be mixed dry by mechanical mixers, with such an amount of water added after such dry mixing as shall be sufficient to produce the proper consistency. Inasmuch as the water to be used for mixing mortar will be naturally taken from the Genesee river, and that stream is at times exceedingly roiley, carrying large quantities of silt in suspension, the contractor must provide settling tanks or reservoirs to the satisfaction of the engineer to be used whenever the river water is unfit for mixing mortar in its natural condition.

In case of the use of small quantities of mortar for some special purpose, the mixing may be by hand with the use of hoes or other mixing tools. The mixing of the mortar will be under the personal supervision of an inspector specially skilled in such work, and his directions and requirements must all be faithfully followed by the contractor and all employes in mortar mixing. When the work of laying masonry is proceeding mortar shall be mixed in such quantities as necessary to keep all parts of the work under way, but in case any surplus is mixed, over what is used at any one time, it must not be retempered and reused, but thrown away.

Granite Masonry.— Granite masonry will be used in large blocks at the lower end of the discharge tunnels, and also for the invert of a portion of the discharge tunnel, as shown on the plans. The large blocks at the mouth of the said discharge tunnels will be dressed to one-half inch joints for at least six inches back from the face and squared up with a chisel draft an inch and a half in width around the exposed edges and with a rock face. The granite arch masonry will be cut to three-eighths inch joints, with bed joints in line with the radius of the circle and with the length, thickness and beds required by the plans. The granite arch masonry will be laid in Portland cement mortar of the specified composition. Centers and forms shall be used for the arch masonry as necessary for the work and as required by the engineer. After the completion of the arches the centers will be removed, the underside cleaned off, and the joints raked out and pointed with pointing mortar. The cost of all centering, as well as the cost of removal, must be included in the price paid per cubic yard for granite masonry. No centering to be removed until directed by the engineer.

The granite used in this work shall be procured from quarries in the State of New York. Granite masonry shall also be used for the ringstones at the ends of the discharge tunnels. The ringstones for such use shall not be of less thickness than 12 inches on the intrados, and shall be dressed to three-eighths inch joints for the full depth of the arch. Joints must be made on truly radial lines. In any case, the ringstone must break joints with the brickwork or granite masonry of the invert at least 12 inches.

Sandstone Rubble Masonry.— The front and rear faces of the dam up to the string course will be composed of sandstone rubble masonry. This class of masonry must be of large stone of good quality, preferably from quarries in the State of New York, laid closely by hand with as few spawls as practicable, in such manner as to present a smooth and true surface. The work will be measured in accordance with the dimensions shown on the drawings or which may be ordered during the work. All stone used must be roughly rectangular, with any irregular projections and feather edges hammered off. For the faces of the dam no stone will be accepted which has a less depth than 2 feet or less thickness than 12 inches. The lengths may range from 3 feet to 8 feet or more if the contractor can readily procure such stone. Generally the average size of stone must comply with the following dimensions: Thickness, 20 inches; depth, 3 feet; length, 6 feet, with variations therefrom as stated in the preceding. In no case shall the depth of the stone be less than the thickness. The sandstone rubble masonry must be bonded with frequent headers from 4 to 6 feet in length, of such frequency and other dimensions as shall be provided by the engineer.

All stone used in sandstone rubble masonry must be thoroughly homogeneous, of unobjectionable quality, sound and durable, free from all seams, discolorations and other defects, and generally of such quality as shall be approved by the engineer. If obtained within the limits of the State of New York the stone will be inspected at the quarry and cut there, thus ensuring that no stone are transported to the dam except such as are satisfactory for the work in hand. It must be understood, however, that the inspection at the quarry will not operate to bar further inspection on receipt of the stone at the dam site, and in the case of the rejection of any stone received there, it shall not be used in the face work, but may be used in backing or retaining walls, as permitted by the engineer.

All beds and joints of sandstone rubble masonry are to be cut true to a depth of at least four inches from the face, with not more than one-half inch joint, the balance of the joints and beds not to exceed two inches in thickness at any one point. All joint space

must be thoroughly filled with mortar. In case any doubt should arise as to this clause having been thoroughly complied with in any part of the work, the engineer may, at his discretion, require the rebuilding of the work. All arrises or chisel drafts must be cut true, well-defined and sharp.

All sandstone rubble masonry will be built generally according to the detailed drawings on Plates H and J; it will be assumed as four feet in thickness, and paid for as though the whole space of the first four feet in depth of the faces of the dam were built entirely of this class of masonry. Where tails of headers extend beyond the four feet line, they will not be paid for.

The face bond of this class of masonry must not show in any case less than 12 inches lap.

The price bid for sandstone rubble masonry must cover the cost of pointing, of cutting chisel drafts at all corners of the buttresses and at other places where corner work may be required, and of preparing the rock faces; but if any 6-cut or rough-pointed work is ordered on this class of masonry, all such shall be paid for at the special price paid for 6-cut and rough-pointed work.

All clauses relating to bedding, jointing, chisel drafts, rock facing and general finish of the masonry which are here specified for sandstone rubble masonry, shall apply as well to granite block masonry.

In addition to the use of sandstone rubble masonry in the face of the dam, as already described, and of the dimensions specified, sandstone rubble masonry will also be used for the face work of the gate house from the foundation up to the level of the string course; when so used smaller stone will answer the requirements, and the thickness will not exceed two and one-half feet, or even somewhat less, if so directed by the engineer. All clauses as to bedding, jointing, etc., will apply to sandstone rubble masonry in gate house the same as to that class of masonry in face of dam. In any case, whether in face of dam or gate house, etc., each block of sandstone rubble masonry must be thoroughly settled to place by heavy pounding.

Backing Masonry.— Backing masonry may be used for the main

interior portion of the dam back of the facing masonry, and also for the interior of the gate house walls, and in such other places as the engineer may specially direct. It shall be made of sound, clean stone of suitable size, quality and shape for the work in hand and presenting good beds for material of that class. All stone for backing masonry may be taken from the excavation, either for the foundations of the dam or from the excavation for the spillway and by-washes and other excavations at the sides. The stone to be obtained from the excavations vary somewhat in quality in different layers and judgment shall be exercised in selecting stone suitable for the work. Any of the natural courses or portions of any natural course which, in the judgment of the engineer, are not suitable for backing masonry, shall be rejected, and when excavated deposited entirely outside the limits of the work at such points as the engineer may specifically direct. Special care must be taken to have the beds and joints of backing masonry full of mortar and no grouting or filling of joints will be permitted after stone are in place. Each stone shall be settled to its place by heavy pounding. The work must be thoroughly bonded. In all cases the stone must be sound and durable and free from any disposition to shatter when soundly struck with a sledge. They must be in roughly rectangular forms with irregular projections, and feather edges hammered off. The beds must be well made for material of this class, and presenting such even surface that when a stone is lowered into place on the level surface prepared to receive it that there can be no doubt about the mortar filling all spaces. Generally speaking, spawls will not be used, but each stone must be allowed to firmly settle into place in its own proper bed of mortar. All vertical joints must be equally filled with mortar. The quality of the beds will regulate to a considerable extent the size of the stones used, as the difficulty of forming a good bed joint increases with the size of the stone. On this point the engineer reserves the right to exercise discretion during the progress of the work. In any case, stones of various sizes must be used and regular coursing avoided, in order to obtain thorough vertical as well as horizontal bonding.

The contractor will bear in mind that the whole object of the work, both as regards the backing and also the sandstone, rubble face masonry is to produce absolutely water-tight work. To this end any and all precautions must be taken in order to secure such final result.

In case when the excavation is opened it turns out that blocks of stone to be used in backing masonry of very large size may be readily obtained, the contractor may, if in the judgment of the engineer and the character of the stone will admit of it, lay such stone on beds of concrete of the composition hereinafter specified instead of on mortar. In case such construction is used the work may be frequently — as the exigencies of the case may require — leveled up with layers of concrete from two to six inches in thickness, on which, after thorough ramming of the concrete, the specially large backing stone may be bedded in mortar substantially in the manner already specified. In using this concrete special care shall be taken to mix it with only a moderate amount of water, which must be brought to the surface by thorough ramming, so that all spaces and joints underneath may be completely filled. Where concrete is used in this manner the space between the stone shall not be less than six inches, in order that proper ramming may be obtained. All such spaces shall be subsequently completely filled with concrete thoroughly rammed. In order to obtain absolute filling of all spaces under the stone, stiff mortar shall be spread over the concrete before the dropping of the stone to place into which the stone shall be thoroughly bedded by heavy pounding. In using concrete in this way care shall be taken to only spread at one time enough concrete to bed one stone, to which the work may be joined, substantially on the same level at the sides. The ordinary precautions as to disturbance before setting shall be taken in all such work.

No extra compensation will be paid to the contractor for the use of concrete for setting large stones, as specified in the foregoing, but the cost of all such must be included in the price bid for the masonry in connection with which the concrete is so used.

Retaining Wall Masonry.— A considerable quantity of retaining

wall masonry will be required for various portions of the work, as shown on the plans. All such masonry will be of the general class of uncoursed rubble masonry with the facing stone of sandstone of the same quality as specified for the faces of the dam, and with the backing of native stone to be obtained from the excavation as already specified for backing masonry. All stone used in the retaining walls shall be hard, sound, durable and of good size and form, free from dust, dirt, earth, etc. Cobble stones and round boulders shall not be used except they are first broken into well-shaped, angular pieces. The greater portion of the stone must have at least one and one-half feet superficial area, but in no case shall any stone be of such magnitude as to extend entirely through the wall, except when specially directed by the engineer. The sandstone face work shall be of large, fair-shaped, durable quarry stone. The face work shall average at least one foot and a half in thickness. Each stone, whether in face or backing, shall be laid upon its broadest and best natural or quarry bed, with a thick layer of mortar of the quality specified for retaining wall masonry, into which it shall be thoroughly settled by pounding. The larger stone must be laid so as to break joints with each other both laterally and transversely, thereby securing the greatest amount of bond and strength. All spaces or interstices occurring between stone must be completely filled with mortar, after which stone chips, fragments or spawls may be thrust therein and hammered in place. Care shall be taken to avoid the formation of large and thick pockets of mortar alone, and stone of the proper size and shape, well bedded in mortar, shall be fitted into all spaces or interstices of considerable magnitude. No spawling under a stone after it is laid will be allowed. On the exposed face of the retaining wall all points or irregular edges projecting more than one inch beyond the face of each stone must be hammered off before laying, in order to leave the finished surface of the walls fairly smooth and true.

Proper attention must be given to bonding and constructing the backing of the retaining walls in the best and most workmanlike manner. After the retaining walls have been built, all joints on

the exposed face shall be properly raked out to a depth of at least one and one-half inches, and then neatly pointed and trimmed up with pointing mortar of the specified composition. As shown on the plan, a number of retaining walls are required for facing up the natural rock at places where, without such walls, the rock would be liable in the course of time to slough off. The back of all such walls must be cemented and grouted fast to the original rock and finished at the top in such manner as to prevent water running down behind the wall between the masonry and the original rock surface. Fine concrete may be used for this purpose for filling all irregularities and spaces in the original rock, when required by the engineer. All concrete so used to be thoroughly tamped to place. Retaining walls shall also be constructed with frequent weep holes or drains, as may be directed by the engineer. Retaining wall masonry will be paid for by the cubic yard for the entire wall, no distinction being made in such walls between facing and backing, but the price shall include the construction of the entire thickness of the wall in accordance with the plans and specifications.

Spillway Wall Masonry.—Spillway walls will be constructed as shown on the plans. The down-stream face of such walls to be composed mainly of large blocks set in steps in order to form the overfall. Inasmuch as this stone will necessarily receive the shock of falling water and ice, it must be specially sound, hard and compact and of the most durable character. All the stone used in the stepping of the spillway must be specially selected and free from faults or defects of every sort and kind. The stepping stone will be of the dimensions shown on the plan, and laid with the back joints not exceeding one inch in thickness; but the first six inches back from the face shall be worked to half inch joints, the same as for the facing stone of the dam. The stepping stone shall vary from four to seven feet in length. The back or water face of the spillway shall be of the same quality of sandstone masonry as already specified for the face of the dam. The backing proper of the spillway, by which is meant the interior filling between the water face wall and the stepping stone, will be of fair size native quarry stone

from the excavation, of the general quality already specified for the backing of the dam itself. The mortar to be used in spillway wall masonry will be of the composition specified for this class of masonry.

Spillway wall masonry will be paid for at a price per cubic yard for the entire wall, said price including the stepping stones, the water face work, as well as the backing.

Rubble Arch Masonry.— The arches of the viaducts at each end of the dam over the by-wash channels shall be made of sandstone rubble arch masonry, the sandstone to be of the same general quality as previously specified for other parts of the work. The rubble arch masonry shall be roughly dressed, to such size and shape as the engineer may direct. The sheeting stone shall consist of selected stone of the full depth of the arch, dressed to at least one-inch joints and laid with a good bearing throughout. No stone shall be less than eight inches in thickness on the entrados. On the exposed fronts at the ends of the arches the ringstone shall be not less than ten inches on the entrados and shall be dressed to one-half inch joints to the full depth of the arch. The joints of the ringstones must be made on truly radial lines and breaking joint with the sheeting stones at least one foot. The face walls of the viaduct above the arches shall be of the same quality as the face of the dam proper, as shown on the plans. The arches shall be properly pointed with pointing mortar of the specified composition.

Gate House Tower and Railing Masonry.— The gate house, towers and railing of the bridge may be constructed of native Portage stone, to be taken either from the best courses from the excavation at the dam site or from the Blue Stone Company's quarry at Blue Stone, about three miles south of Portage, as may be decided by the engineer. All masonry of the gate house, towers and bridge railing shall be finished with either rock or quarry face, rough-pointed or fine-hammered (6-cut) dressing, as may be directed by the engineer. Rough-pointed or fine-hammered dressing will be paid for at a price per square foot in addition to the price bid for masonry, but the price of dressing, including the cutting of

arrises or chisel drafts on rock- face work, must be included in the price for gate house, tower and railing masonry.

In addition to the use of native Portage stone for the gate house, tower and bridge railing, it may also be used, if so directed by the engineer, for the ornamental string courses on the front and rear of the dam. In case it is so used, the price bid for facing masonry will be considered as covering the cost of all native Portage stone so used. The dressing, other than rock or quarry face, to be paid for in addition to the price for facing masonry at the price per square foot bid for rough-pointed or fine-hammered (6-cut) work.

In rock-face work the arrises or chisel drafts of the stone inclosing the rock face must be pitched to true lines, with bold projections of from three to five inches beyond the arrises. The angles of all walls having rock faces are to be defined by the chisel draft, not less than one and one-half inches wide on each face.

In rough-pointed work the stone shall at all points be full to the true plane of the face, projecting at no place more than one-fourth of an inch, with sharp and well-defined arrises, each stone to have its arrises well defined by a chisel draft, all of which must be included in the price bid per square foot for rough-pointed dressing.

In fine-hammered work the faces of the stone must be brought to a true plane, and fine dressed with a hammer having six blades to the inch.

In measuring cut stone masonry, in case the stone are not rectangular, the dimensions taken of each stone will be those of a rectangular cubical form, which will just include the neat lines of the stone measured.

The price bid for all masonry is to include the cost of preparing all holes, recesses, etc., necessary for handling the stone by cable and derrick. The price shall also cover the cutting of all irregular surfaces and curved work of whatsoever sort or kind.

The exposed parts of cut stones are generally to be prepared with rock faces. Inside surfaces and copings are generally to be rough pointed. Gateways, curves, sills and other surfaces so designated by the engineer will be fine hammered.

Brick Masonry.— Brick masonry will be used for the arch rings of the discharge tunnels, except as herein specified, for the use of granite masonry. It will also be used for facing work in the gate house and for the passageways through the dam, to such extent as may be specially directed by the engineer.

The brick to be used in the work shall be of the best quality, new, whole, sound, compact, hard-burned throughout, free from all injuries, cracks and with true and even faces and edges. They shall be culled by the contractor as they are delivered upon the work, and any broken or defective brick at once broken up for use in concrete or else removed entirely outside the limits of the work. To insure their good quality all brick furnished by the contractor will be subject to inspection and ordinary tests as to crushing and absorption, and if found of improper quality will be condemned, the special character of all the tests to be determined by the State Engineer and Surveyor. In any case, they must show an ultimate crushing strength of at least 4,000 pounds per square inch when tested, either on their beds or on their sides.

All brick shall be thoroughly wet just before laying; the mortar shall be of the quality specified in the foregoing for brick masonry. For arch work they shall be laid to a line with the beds in the line of the radii of the curves and with the joints not exceeding three-eighths inch in any of the back rings. The entrado ring to be laid to quarter-inch joints. Every brick shall be completely bedded in mortar at its bottom, side and end at one operation. In no case shall any joint be made by working mortar into the same after the brick has been laid, nor shall any portion of the brickwork be laid dry and afterwards grouted. In the arches of the discharge tunnel the brick must be laid with the English bond, one header course alternating with not more than four stretcher courses.

The intersection of the vertical shafts with the discharge tunnel shall be neatly groined and arched in the most workmanlike manner, with special reference to the proper keying of the tunnel arches. Care shall be taken to leave all exposed surfaces true and regular. The interior surfaces of the tunnels shall be rendered smooth by scraping off the projecting mortar immediately after removing the

centering, and skillful mechanics shall be employed for all this work. Brickwork will also be used for facing in the gate house so far as may be directed by the engineer. All such work will be laid with the English bond, the same as specified for tunnel masonry. In any case the mortar joints in the facing work shall not exceed from one-fourth inch to three-eighths inch in thickness in any place. Special care must be taken to secure a strong bond at all angles and corners.

Unfinished brickwork must be thoroughly racked or toothed back as directed, and when new work is joined to it the surfaces of the bricks previously laid must be scraped and thoroughly cleaned by scrubbing with a stiff brush, and be well moistened before fresh mortar is applied thereto.

Brick masonry will be laid in Portland cement mortar of the quality specified for that class of masonry.

Concrete Masonry.—Concrete masonry will be used for the cut-off trench at back of dam and under the spillway wall, as shown on plans. It will also be used for leveling foundations, and in such further places as the engineer may direct. Also, in case the State Engineer and Surveyor shall so direct, concrete may be used for the backing of the dam, instead of backing masonry, as already specified. In any case, the price bid should be with reference to the possibility of its use extensively for such work, but in the case of its use in the backing, for bedding large rubble stone, as already specified, the price bid for backing masonry must include the cost of the concrete. The intention of the specification is to only pay the separate price for concrete in the backing, when concrete shall be used therein exclusively, taking the place of backing masonry.

Concrete will be made of Portland cement mortar of the quality specified for concrete masonry, and of aggregate material to be obtained from the excavation.

The aggregate material shall consist of clean fragments of hard and durable stone or brick broken to such size as will pass freely in largest dimension through a two-inch ring. If so directed by the engineer, a certain portion of the concrete shall consist of clean gravel, ranging in size from gravel stone, capable of passing through said two-inch ring, and from that down to pebbles not smaller

than one-fourth inch in diameter or thereabouts. In order to comply with this requirement, it would be necessary that gravel containing any large amount of fine pea gravel or sand should be screened. In any case, all of this concrete material shall be free from dirt, earth, clay or other improper substance. If required by the engineer, it shall be washed before being mixed with any cement mortar. In forming concrete such a proportion of mortar of the specified composition will be used as may be found necessary by trial to a little more than fill the voids in the aggregate. Tests of the voids will be made from time to time under the direction of the engineer, and instructions given as to the per cent. of mortar of the specified composition to be used. For the information of the contractor, in the way of computing the cost of concrete of the quality herein required, it may be stated that ordinarily the per cent. of mortar will be about 33 per cent. of the measured volume of the aggregate. In case of the use of a certain proportion of gravel in the aggregate, the proportion of mortar may be reduced to somewhat less than 30 per cent. In forming concrete the required proportions in units of volume of the component materials shall be mixed thoroughly together in an approved mechanical mixer. In forming mortar to be used in concrete the sand and cement shall be mixed dry with the water subsequently added, as already specified under the head of mortar. In warm weather aggregate material shall be wet a short time before using. In case of the use of small quantities of concrete the mixing may be by hand by repeatedly turning over with shovels upon a suitable plank platform. Whether machine or hand mixed, as soon as the mixing is completed, the concrete must be deposited rapidly in layers in the place where it is required to be used, and be immediately thoroughly pounded or rammed in a manner satisfactory to the engineer, until the water flushes to the surface and all the interstices of the aggregate material are entirely filled with mortar. Should voids be discovered when the forms are taken down, or otherwise, the defective work must be removed and the space refilled with suitable material, properly manipulated, at the contractor's expense.

The contractor will furnish at his own expense all lumber for forms, for laying and depositing concrete, as well as the necessary labor and ironwork for erecting, maintaining and removing the same. All forms shall be set true to the lines designated and so built as to remain firm and secure until the concrete is properly hardened. In case concrete shall be directed to be used for the backing of the dam the work will be built in large blocks, breaking joint one upon the other, as directed by the engineer. The forms will be erected for such blocks, with space enough between the blocks to admit of readily taking down the forms after the completion of the blocks; such space to be subsequently filled with concrete, properly rammed. In depositing concrete the layers shall be made of such thickness as the engineer may direct, though generally a thickness of layer of from six to nine inches will be sufficient. The attention of the contractor is specially called to the fact that all of the concrete work will be required to be rammed in the most thorough manner. Generally, as small an amount of water will be used in mixing as is consistent with the complete combination of the water with the cement, thereby necessitating exceedingly thorough ramming in order to absolutely consolidate the mass. The contractor is given due notice of this provision in order that he may fully understand the requirement of thorough ramming. In case the State Engineer and Surveyor shall decide to use concrete masonry, as previously described, the contractor may, if he so elect, use mechanical appliances for ramming — such appliances being satisfactory to the engineer, both as to form and results obtained.

All concrete shall be allowed to properly set after being deposited in place and rammed as aforesaid, before walking over it or any disturbance of the surface by the operations of construction shall be permitted. Any concrete which has been either accidentally or otherwise disturbed shall be, when required by the engineer, removed and new work substituted in its place. The exact time required for setting, and during which there must be no disturbance, will be determined by the engineer. It will depend upon the setting qualities of the cement used, as ascertained from the tests, and also from practical use in the work.

Generally speaking, the exigencies of this work will not require the leaving of any lumber of forms in place in the work. If, however, such a case should arise, and the engineer directs the leaving of any lumber of forms in place in the work to be built in, all lumber so left will be paid for at a price to be determined by the engineer.

The contractor will take all necessary precautions for protecting fresh concrete from either the effect of the sun during warm weather or against freezing in cold weather. In warm weather the freshly-laid concrete, when required by the engineer, shall be fully protected by the use of tarpaulins or canvas coverings. It shall also be thoroughly wet with water several times a day, as may be directed by the engineer. In case the laying of masonry should be permitted in extreme freezing weather, freshly-laid concrete may be protected in like manner by the use of tarpaulins or canvas coverings and freezing prevented by running steam pipes under the said covering. The foregoing special requirements as to wetting, covering and protecting newly-laid concrete must also be applied to all other classes of masonry, if so required by the engineer.

Asphaltic Concrete and Masonry.— At points where special precautions for making water-tight work are required, the masonry may be constructed either of asphaltic concrete or asphaltic masonry, as the case may be. The asphalt used in any such work must be specially refined and brought to uniform standard of purity and gravity of a quality to be approved by the engineer. In any case the asphalt shall not lose more than 4 per cent. of its weight when maintained for ten hours at a temperature of 300° F. The use of coal tar, petroleum residuum, so-called artificial asphalts or other products which are susceptible to injury through the action of the water will not be permitted in any portion of the work, or any of the mixtures to be used. The asphaltic concrete shall be composed of asphalt heated, melted and properly manipulated, as the engineer may direct, and broken stone. The stone shall be broken to pass through a two-inch ring, and shall be used as it comes from the crusher, without screening. Gravel, sand and lime dust shall

be added thereto in proper proportions, as the engineer may direct. The broken stone, with its admixture of gravel, sand and lime dust shall be heated in suitable heaters to such temperature as the engineer may direct, and when so heated the melted asphalt added thereto in such proportions as will ensure the covering of each particle of sand, gravel and dust with asphalt, and the whole mass then mixed and incorporated into a suitable mixture. The mass then formed shall be deposited in a place while still hot, in suitable boxes or forms, as the case may be, or as the engineer may direct, and be thoroughly rammed with hot rammers. The form shall be substantially constructed as already described for ordinary concrete forms.

Where so required by the engineer, masonry will be laid with asphalt joints or asphaltic mortar in the following manner: The asphalt, properly tempered with a suitable flux, shall be melted and heated to such a temperature as the engineer may direct, and, while so heated, mixed with clean, sharp sand and dust which have been previously heated in such proportions as to form a rich, adhesive mastic. The stone, which shall also have been previously heated, shall be laid while hot in the asphaltic mortar above described, or, if so directed by the engineer, the stone may be dipped cold in asphalt dissolved in petroleum naphtha, and after said coating has become dry, shall then be laid in the hot asphaltic mortar as above described.

Additional Clauses with Regard to Masonry.— The word masonry, as used in this specification, will be understood to include all stone masonry, whether of granite, sandstone or native Portage stone, as well as brick and concrete masonry; and the foregoing specification as to masonry is to be understood as referring to the dam, gate house, ornamental towers, string courses, roadway, arch bridges, retaining walls and all other appurtenances incidental to the completion of the whole work in accordance with the full intent of the plans and specifications. All bricks and stones must be perfectly clean when being laid, and care shall be taken to prevent any earth or other foreign substance from dropping upon the masonry or becoming incorporated therein during the process

of construction. Any such substance accidentally falling upon unfinished work shall be removed before the masonry at the point where it falls is continued.

Centers and forms for the tunnel, roadway and other arches, and satisfactory molds, forms and bracings for the concrete work, when required, shall be provided and maintained in good condition at the contractor's expense. They shall always be carefully cleaned before using. Centerings shall not be removed until so directed by the engineer. In the discharge tunnels the centers and forms shall be constructed in such a manner that the rear ones may be removed and carried forward to be set up again in front as fast as the arch work of the tunnel is completed. No water shall be allowed to stand upon, or over, or against any fresh masonry until the mortar has had ample time to set, for such period as may be determined by the engineer. If work be carried on in cold weather, by permission of the engineer, the necessary means for warming brick, stone, sand, cement and water shall be provided by the contractor at his expense, as well as the necessary steam plant and appliances for preventing freezing, in the manner already specified for concrete. The said methods of preventing freezing of concrete to be also applied, if directed by the engineer, in the case of constructing the interior of the dam of ordinary backing masonry instead of concrete. At any time, however, when the weather may be considered unfavorable by the engineer the work must be suspended as he may direct. The work must, in general be made water-tight at all points, and if, after the work is completed and tested, any leaks are discovered, the openings must be caulked or otherwise securely stopped. Any defects in the work, from any cause, on the contractor's part which may be discovered at any time, shall be immediately corrected at the contractor's expense, even if it be necessary to take down and entirely rebuild portions of the work. Furthermore, the engineer shall have the right to test the masonry by borings from the top down through, or by borings from the discharge tunnels, or from the face, or in any other manner which he may deem necessary to thoroughly satisfy himself that the work has been constructed in all of its parts

in accordance with the intent of the plans and specifications. All damage done to the work by such borings, tests, etc., shall be repaired by the contractor at his own expense. In case of discovering defects, all such shall be at once remedied by injecting cement grout, under pressure from a suitable pump, or by taking down and properly rebuilding the work in accordance with these specifications, or by such other means as shall be approved by the engineer. In case cement grout is used for such repairing of defects, the same shall be prepared by mixing not more than one part of sand with one similar part of cement. It must be thoroughly understood that the inspection of workmanship and materials furnished by the contractor, and their acceptance by the inspectors, engineers or other agents of the State, shall not relieve the contractor from any responsibility or obligation in the proper performance of the work. Estimates as to the quantity of the work performed will be made from measurements of the number of cubic yards built in conformity with lines given by the engineer and in conformity with the plans, and all the limitations and conditions of the said plans made by the direction of the engineer. No allowance for angles or corners will be made in any case, and all openings will be deducted. No constructive or conventional measurement of the volume of any kind or class of masonry will be allowed, but all measurements of masonry shall be made by the cubic yard, or of face work by the square foot.

The roofing of gate house and towers and the doors, windows and interior finish of the same will be in accordance with detailed plans to be furnished during the progress of the work. The general character of the roofing is shown by the plans submitted at the letting. The doors, windows and interior finish will be a plain, hardwood finish, with the necessary iron railings, all of a plain and simple character. Iron railings and circular stairways will also be required for the passages through and under the towers as shown on the plans. The doors will be bid for at so much per door; windows and window frames at so much per window, with a lump sum for roofing and interior finish. Iron railings, stairways and all other ironwork, including the necessary iron bolts for attaching

gate frames, etc., to the masonry, with the slide gates and operating mechanism connected therewith, will be paid for at a price per pound, said price to include cast iron and wrought iron work as well, together with any small amount of bronze work that may be required.

The necessary cast iron pipe and pipe specials will be paid for at a price per net ton.

Stop gates will be paid for at a price per gate.

Pipe laying will be paid for at a price per lineal foot.

Turbine water wheels will be paid for at a price per wheel set in place; with the necessary shafting and gearing connected therewith, etc., at a price per pound.

Electric light plant with lamps, wiring, etc., will be paid at a price for the plant complete, except turbine water wheels, to furnish 50 incandescent lights of 50 candle power each, and seven arc lights of 1,000 candle power each.

It is proposed to operate the large slide gates in the gate house by compressed air, also to arrange for ordinary operations of other gates by compressed air controlled from the gate house. The necessary air compressor, receiver and connections for accomplishing this will be paid for at a lump sum for the plant complete, except turbine water wheel.

It is also proposed to erect a weir dam with automatic gaging appliances across the Genesee river at a convenient point a short distance below the upper Portage fall. The said dam will be erected in accordance with the plans and the directions of the engineer, of sandstone masonry of the quality herein specified for the faces of the dam. The price bid for erecting said gaging dam, including the gaging appliances and the gage house, about eight feet square, must be a lump sum, the said sum to include the making of the necessary foundation excavation, the furnishing and laying of the masonry and all other materials and appliances required of every sort and kind, as well as the erection of a gage house and the furnishing of the gaging appliances of such pattern as may be satisfactory to the engineer. The gaging dam must be a water-tight structure.

Asphalt Roadway Across Dam.— The roadway over the dam between the stone railings shall be made of asphalt, in accordance with the following specifications. The sub-surface must be brought to a uniform grade with concrete, as shown on the cross sections. This will be accomplished by filling all depressions and irregularities in the masonry with concrete, to be composed of clean, broken stone and mortar of the quality already specified for concrete; the concrete so deposited to be worked to the curve of the crown on the roadway when finished.

After the ordinary concrete has fully set the base of the roadway proper may be made by placing a layer of fine concrete, composed of clean stone, not exceeding one inch in their largest dimensions, thoroughly screened, and coal tar residuum commonly known as No. 4 paving composition. If so directed by the engineer, clean, sharp sand may replace a portion of the broken stone. The stone, or stone and sand to be used for this purpose, must be heated and thoroughly mixed with the paving composition in the proportion of one gallon of paving composition to one cubic foot of stone. This material must be hauled to the work and spread with hot iron rakes and made thoroughly true, so that when compacted by tamping and hand rolling, the surface shall have a uniform grade and cross section exactly corresponding to the curve of the upper surface of the road when complete.

Upon this binding material the wearing surface or asphalt paving proper will be laid. The said wearing surface must be composed of (1) refined asphaltum; (2) heavy petroleum oil; (3) fine sand, containing not more than 1 per cent. of hydro-silicate of aluminum; (4) fine powder of carbonate of lime. The asphaltum used for the roadway proper must be specially refined and brought to a uniform standard of purity and gravity and generally of a quality approved by the engineer, the same as in the case of asphalt used for asphaltic concrete and masonry.

The heavy petroleum oil must be freed from all impurities and brought to a specific gravity of 18° to 20° Baume, and a fire test of 250° F. From these two hydro-carbons an asphaltic cement shall be manufactured, which shall have a fire test of 250° F. and at

a temperature of 60° F. a specific gravity of 1.19. Said cement to be composed of 100 parts of pure asphalt, and 15 to 20 parts of the heavy petroleum oil.

Pavement mixture will be composed of asphaltic cement made in the manner above specified, and sand and pulverized carbonate of lime, in the following proportions: Asphaltic cement, from 12 to 15 per cent.; sand, from 83 to 70 per cent.; and pulverized carbonate of lime, from 5 to 15 per cent. The sand and asphaltic cement are to be heated separately to about 300° F. Pulverized carbonate of lime, while cold, shall be mixed with the hot sand in the required proportions, and then mixed with the asphaltic cement at the required temperature and in the proper proportions in a suitable apparatus which will effect a perfect mixture. The pavement mixture must be delivered on the work at a temperature of 250° F.; as soon as delivered, it shall be carefully spread by means of hot rakes, in such manner as to give a uniform and regular grade, and at such depth as, after receiving its ultimate compression, it shall have a thickness of one and one-half inches at the crown of the roadway, tapering off to about one inch at the gutters. The surface shall be first moderately compressed by a hand-roller, after which a small amount of hydraulic cement shall be swept over it, and it shall be then thoroughly compressed by as heavy a hand-roller as can be used, the rolling to be continued for not less than eight hours for every 200 square yards of surface.

The powdered carbonate of lime must be of such degree of fineness that from 5 to 15 per cent. of the entire mixture for the pavement shall be of an impalpable powder of limestone fine enough to entirely pass through a No. 26 screen. The sand must be of such size as to remain on a No. 80 screen, and to all pass through a No. 10 screen.

In order to make the gutters entirely impervious to water a width of 12 inches next to the stone railings must be coated with hot, pure asphalt and smoothed with hot smoothing irons, in order to saturate the pavement to a certain depth with an excess of asphalt. In order to make the drainage of the roadway across the dam perfect, the gutters shall be slightly inclined from points

designated by the engineer to drain openings, to be left with drains built in the masonry, and delivering through the wall on the back, or water face thereof, a short distance above the ordinary water level at points designated by the engineer. The asphalt pavement shall be constructed in all particulars to the satisfaction of the engineer. It will be paid for at a price per square yard, which price must include the furnishing of all labor, material, tools and appliances of whatsoever sort and kind.

Passageways Through Dam.— A series of passageways through the dam, leading from the gate house to the discharge tunnels will be constructed as shown on the plans. The cost of centers, etc., and all labor of constructing these passages must be included in the whole work. The space of the passages, as well as the discharge tunnels, will be deducted from the final measurement.

Increase or Diminishment of Quantities.— The State reserves the right to increase or diminish the amount or amounts of any class of work from the quantity shown on the bidding sheet. In every case the amount of work finally required will be constructed at the prices named in the contract, and no claims shall be made for damages or prospective profits by reason of increase or diminution of quantities.

Explanation of Plans and Specification.— For a more full and perfect explanation of the forms and dimensions of materials and parts, and of the manner of performing the work in all its details, plans with bills of material will be furnished by the engineer, who will also give such directions from time to time during the progress of the work as may appear to him necessary in order to make the work in every respect complete and perfect as contemplated in the plans and specifications, and such directions of the engineer shall in every respect be complied with.

Inspection.— All materials and work shall be subject to inspection until finally accepted by the State Engineer and Surveyor and the Superintendent of Public Works. Any labor or material or improperly constructed work if discovered before such final acceptance, shall be promptly replaced by suitable material and proper construction at the contractor's expense.

Delivery of Material.— The quarrying of stone and the delivery of the same, as well as the delivery of all other material, shall progress to the satisfaction of the engineer.

Engineer.— Where the word "engineer" occurs herein without special designation, it shall be understood to mean the person officially directed by the State Engineer and Surveyor to take charge of the work.

Final Acceptance.— Final acceptance of the work contracted for under these specifications shall be jointly vested in the State Engineer and Surveyor and the Superintendent of Public Works.

When the contractor shall consider that he has fully completed his work he will report the fact in writing to the engineer, who will promptly inspect the work and report his conclusions to the State Engineer and Surveyor. Upon the receipt of such report as satisfies the State Engineer and Surveyor and Superintendent of Public Works that the terms of the contract have been fully complied with, a written notification of acceptance will be issued to the contractor. Until such notification is issued, or the settlement of final account made, the contractor shall remain fully bound by all the conditions of this contract.

Estimates.— Estimates will be made as per the rules of the Canal Department, of the work actually constructed and material delivered on the ground for the work from month to month, as the basis of payment. Ten per cent. of all such estimates shall be retained by the State until the making of a final estimate for the final settlement.

Compliance with Laws.— The contractor will conform to all the provisions of Act, Chapter 277 of the Laws of 1894, and Chapter 413 of the Laws of 1895, relating to the dressing and carving of stone used in State work, and also to the provisions of Act, Chapter 622, Laws of 1894, relating to the hours of labor and rate of wages and the employment of citizens of the United States.

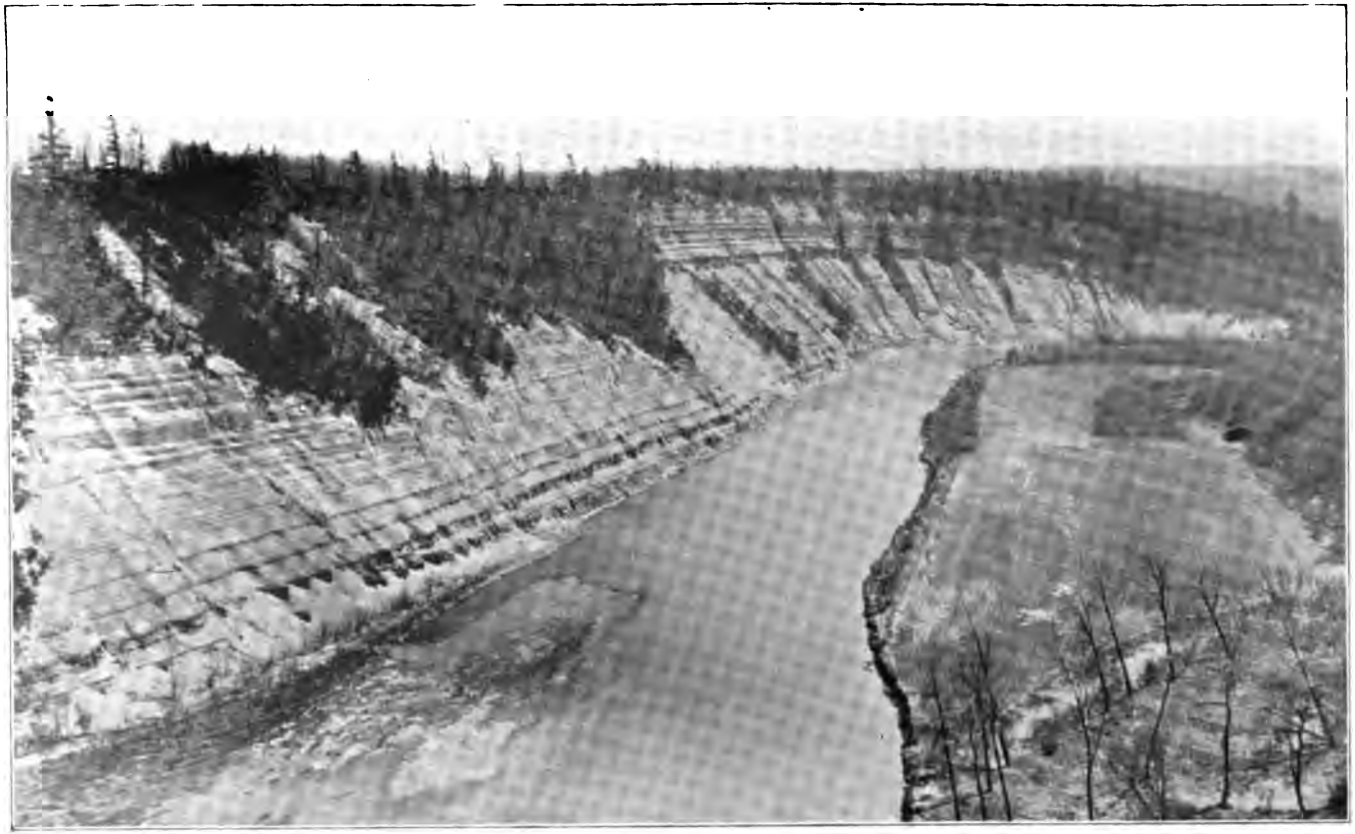


Plate I. View of the Mount Morris Canyon, Showing its Ordinary Width.

Plate III. View of Main Street, in the City of Rochester, Looking West, as it appeared on the Morning of March, 19, 1865.

Plate IV. View of the Erie Canal Aqueduct over Genesee River as it appeared in the 1865 Flood.

Plate IV. VIEW OF THE ERIE CANAL AQUEDUCT OVER GENESEE RIVER AS IT APPEARED IN THE 1865 FLOOD.

Plate V. View Looking up State Street and Exchange Street, in the City of Rochester, in the 1865 Flood.

Plate VI. Looking down State Street from near Church Street at the time of the 1865 Flood.

Plate VII. View of Front Street, Looking toward Main Street, in the City of Rochester, after the 1865 Flood

Plate VIII. Another View of the Erie Canal Aqueduct over the Genesee River at the time of the 1865 Flood.

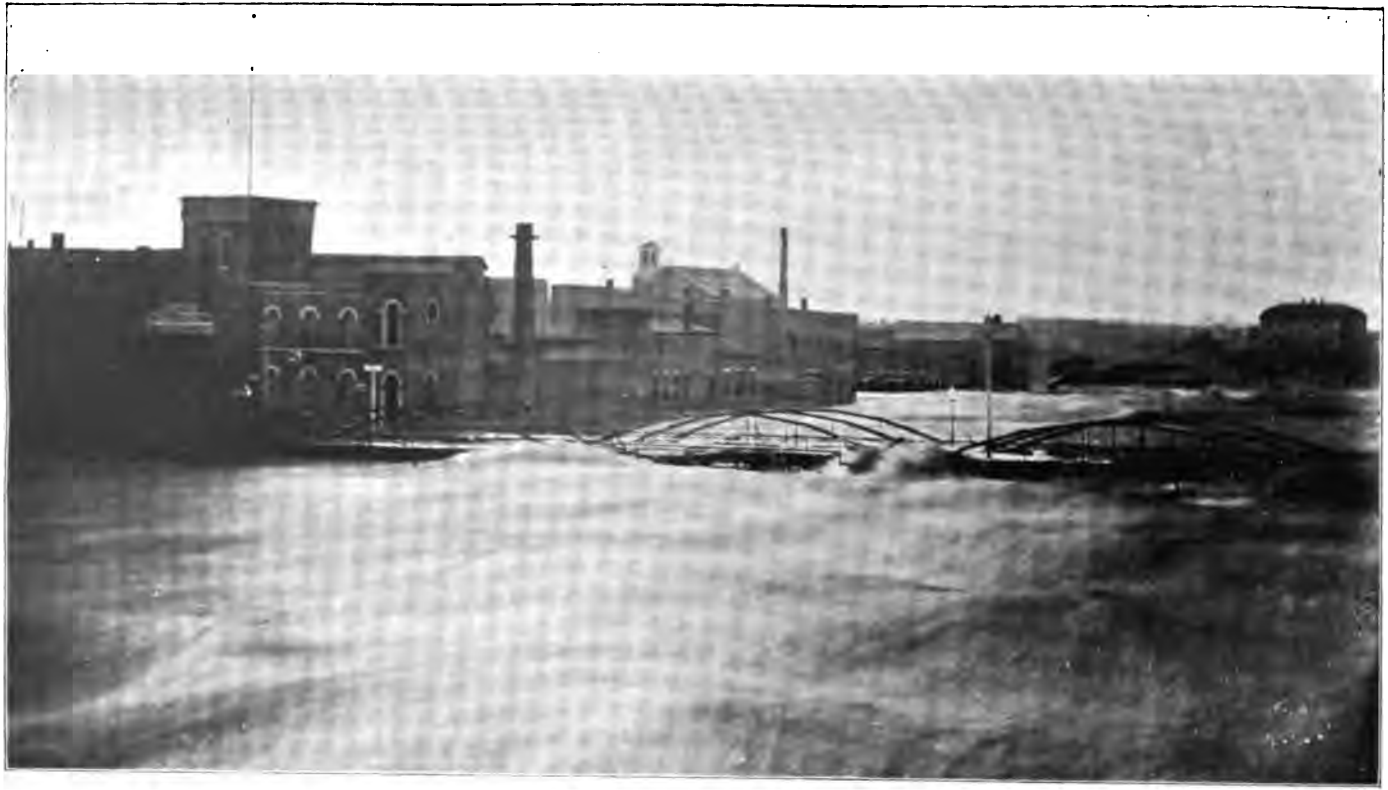


Plate IX. Andrews Street Bridge, in the City of Rochester, during the 1865 Flood.

Plate X. Ice Left in the Streets of the Lower Part of the Village of Mount Morris by Flood of March, 1893

Plate XI. INUNDATION OF FLATS AT MOUNT MORRIS, MAY 23, 1894.

Plate XII. New Channel Cut by the Genesee River through the Farm of Byron Swett, May 22–24, 1894.

Plate XIII. The Erie Canal Aqueduct over the Genesee River as it appeared in the Flood of April 4, 1896.

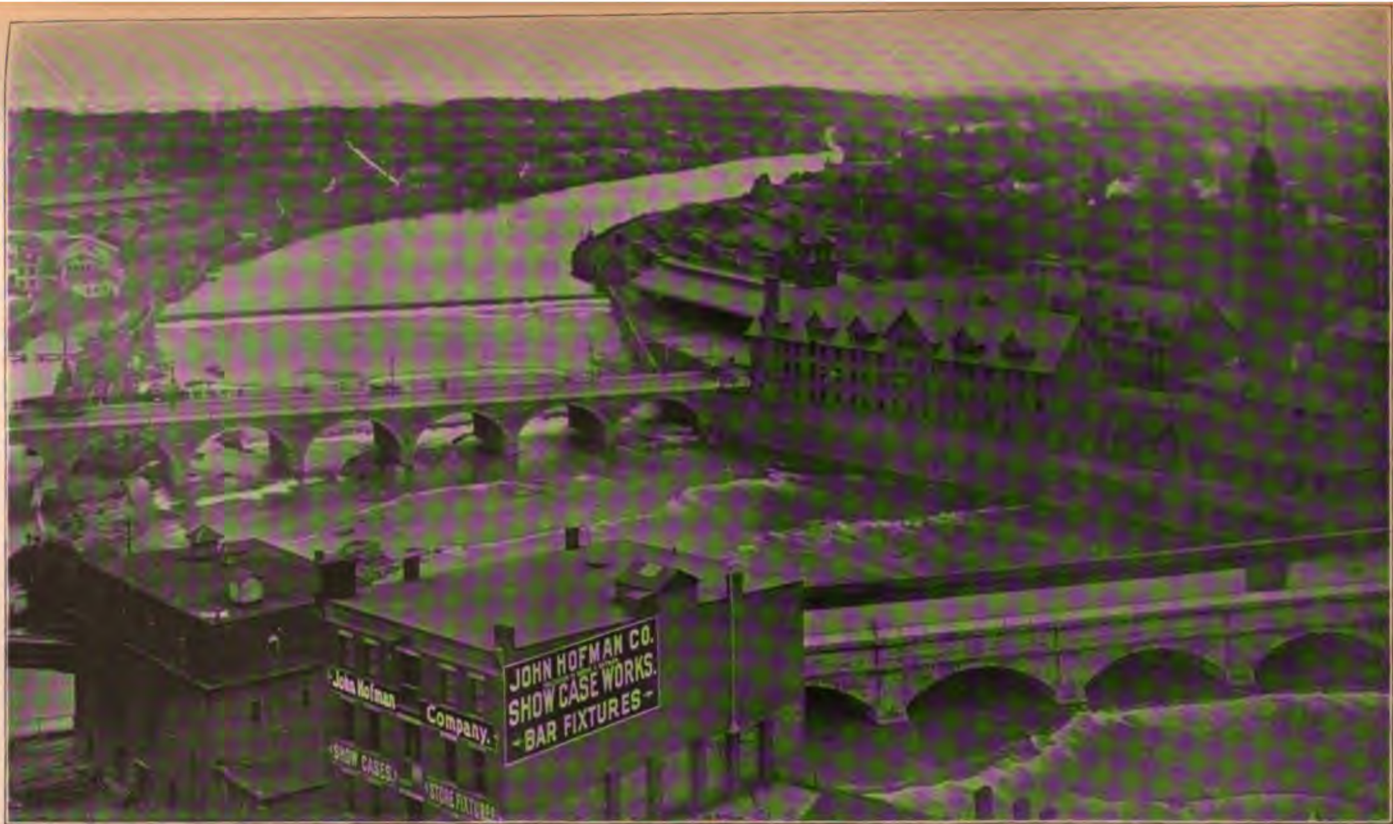


Plate XIV. THE GENESEE RIVER, IN THE CITY OF ROCHESTER, FROM THE ERIE CANAL AQUEDUCT TO AND ABOVE THE JOHNSON AND SEYMOUR DAM.

Plate XV. The Erie Canal Aqueduct at Rochester and the South Side of Main Street Bridge.

Plate XVI. THE PRESENT ANDREWS STREET BRIDGE IN THE CITY OF ROCHESTER AND THE GENESEE RIVER TO THE SOUTH OF THAT BRIDGE

Plate XVII. The Upper Fall at Rochester at time of Low Water.

Plate XVIII. THE UPPER FALL AT ROCHESTER WITH MEDIUM FLOW.

Plate XIX. The Upper Fall at Rochester at time of Flood Flow.

Plate XX. The Middle Fall at Rochester.

Plate XXI. The Lower Fall at Rochester—The Middle Fall in the Background.

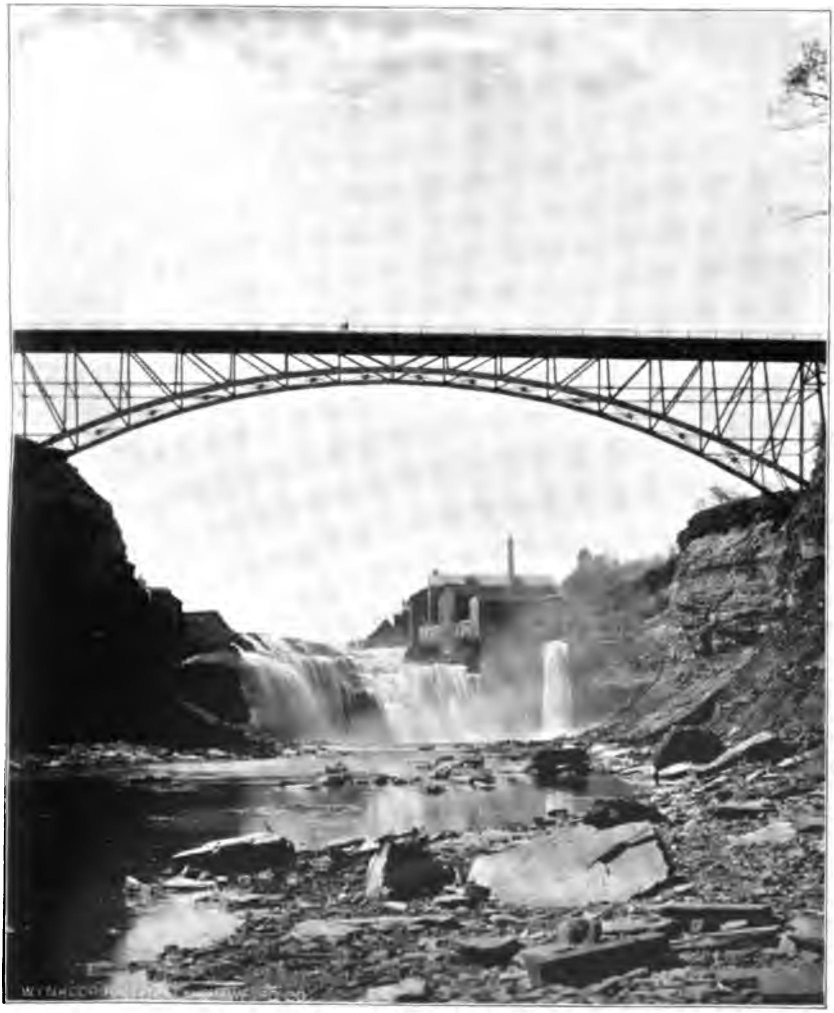


Plate XXII. ANOTHER VIEW OF THE LOWER FALL AT ROCHESTER.

Plate XXIII. A View of the Manufacturing District at Rochester.

FIG. XLV. ANOTHER VIEW OF THE ROCHESTER MANUFACTURING DISTRICT.

Plate XXV. Ancient Lake Benches in Upper Genesee Valley above Fillmore.

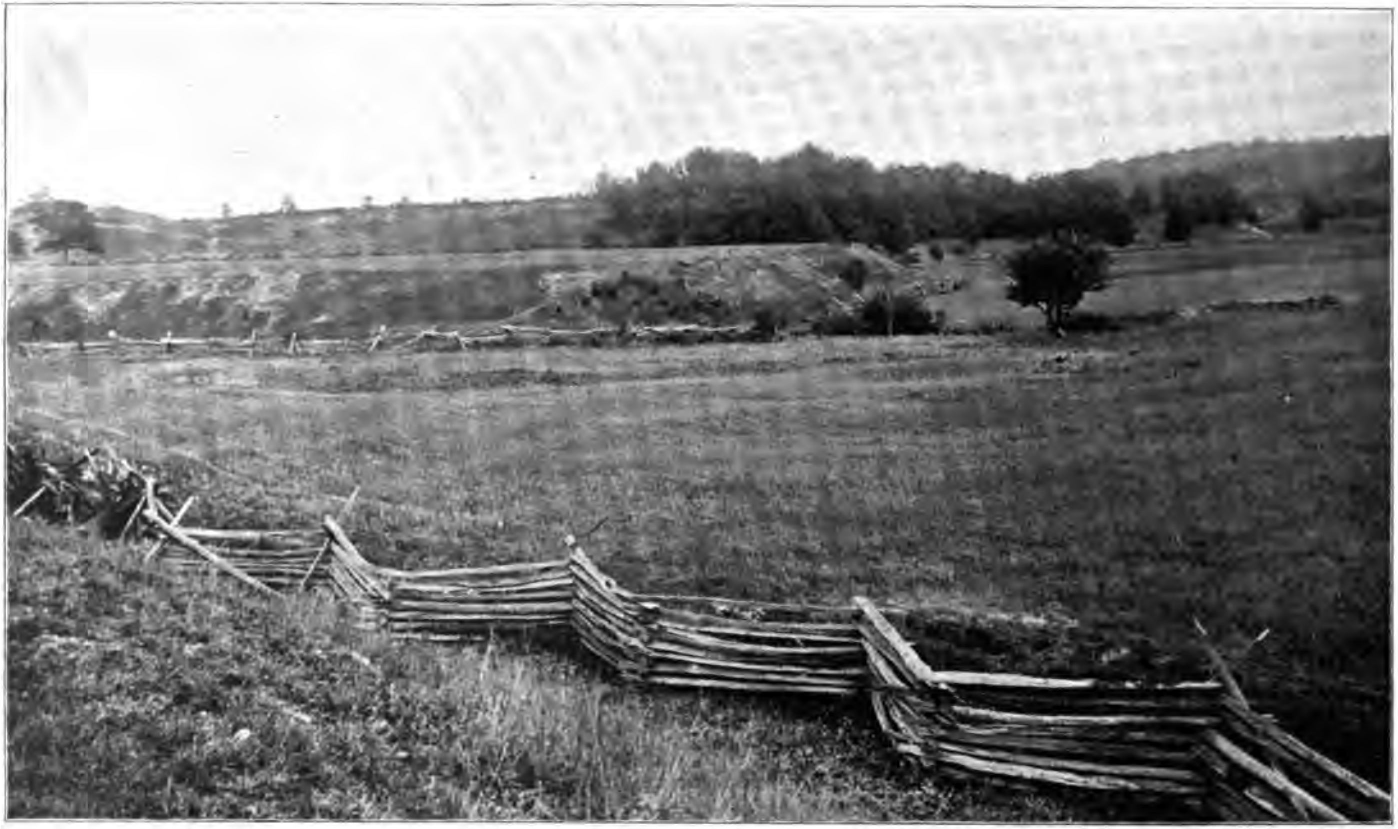


Plate XXVI. Another view of Ancient Lake Benches in the Upper Genesee Valley.

Plate XXVII. Still Another View of the Ancient Lake Benches in the Upper Genesee Valley.

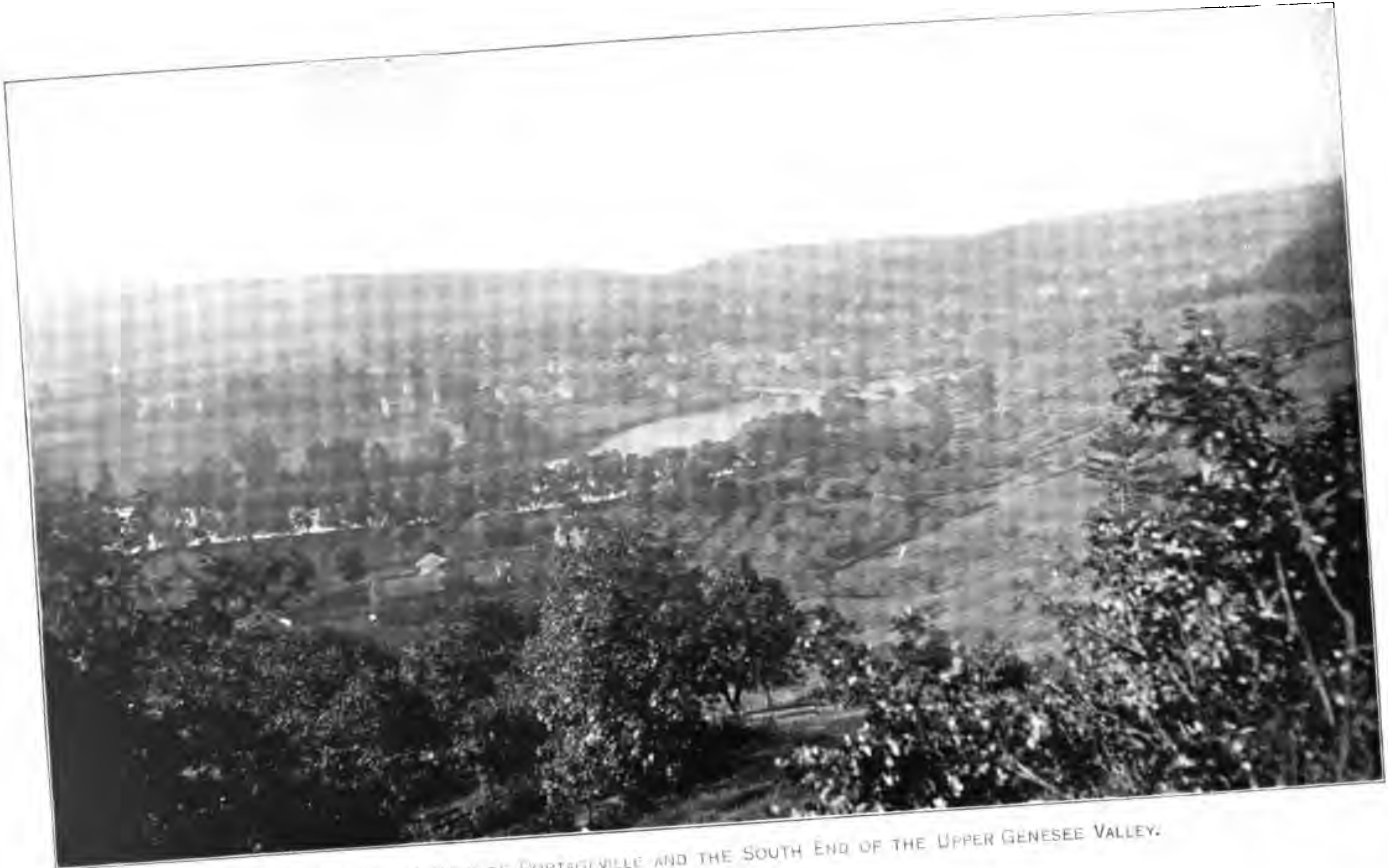


Plate XXVIII. A View of Portageville and the South End of the Upper Genesee Valley.

Plate XXIX. A View of the Village of Fillmore—the Water Level of the Proposed Reservoir to be ten feet above the Railway.

Plate XXX. Another View of the Village of Fillmore.

Plate XXXI. THE GENESEE RIVER WEIR FROM BELOW.

Plate XXXII. Side View of Genesee River Weir.

Plate XXXIII. View of the Genesee River Weir from Upstream.

Plate XXXIV. THE UPPER FALL AT PORTAGE.

Plate XXXV. General View of the Middle Fall at Portage

Plate XXXVI. THE MIDDLE FALL AT PORTAGE FROM BELOW.

Plate XXXVII. THE MIDDLE FALL AT PORTAGE AS TAKEN FROM THE

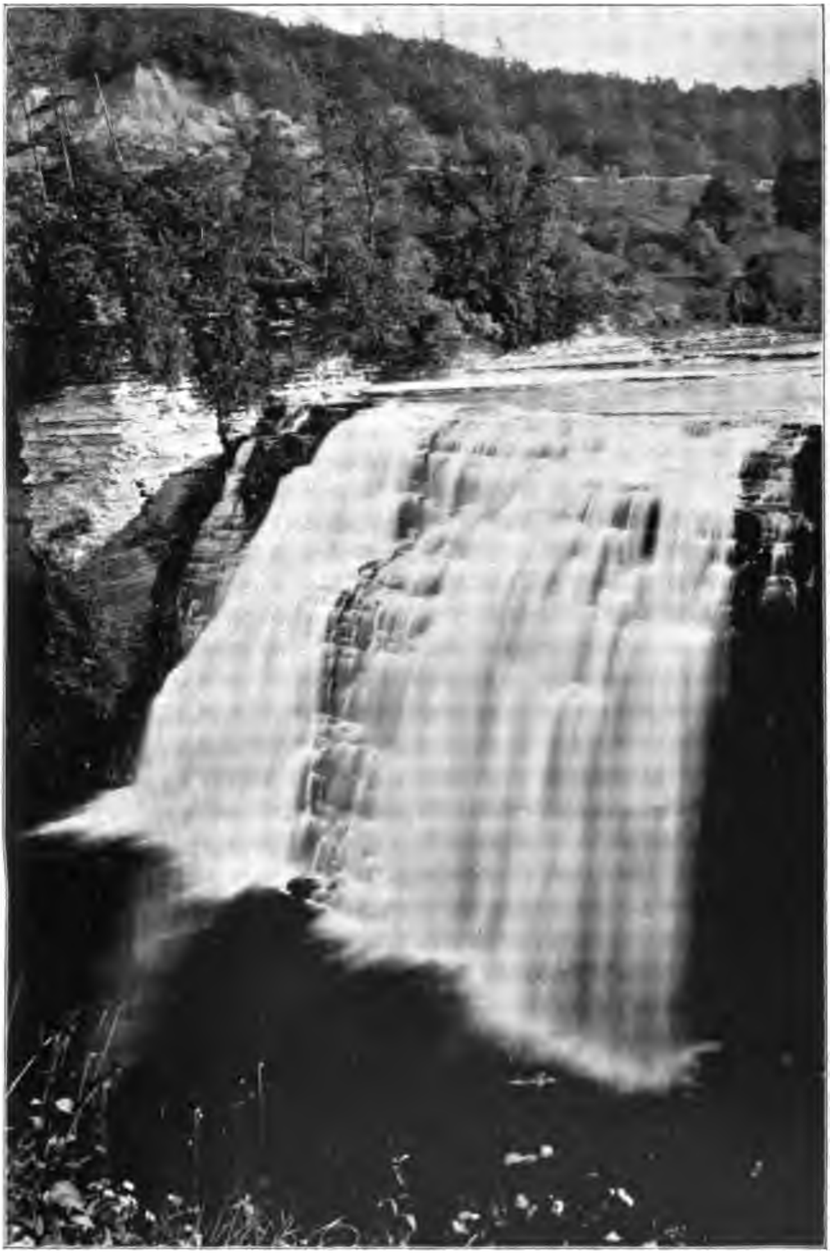


Plate XXXVII. THE MIDDLE FALL AT PORTAGE AS TAKEN FROM THE WEST BANK.

Plate XXXVIII. General View including both the Upper and Middle Falls at Portage.

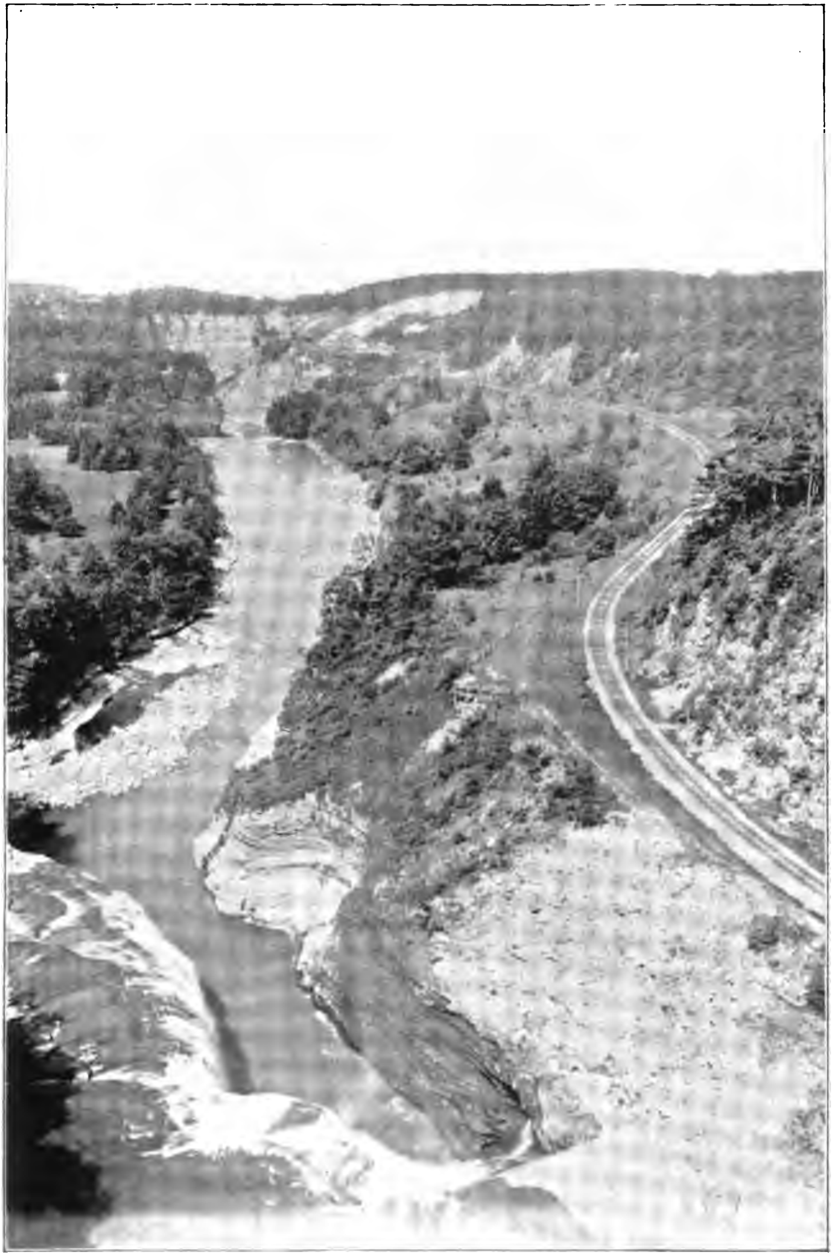


Plate XXXIX. View down the River from the Erie Railway Bridge
Showing Brink of Upper and Middle Falls.

Plate XL. THE LOWER FALL AT PORTAGE.

Plate XLI. Another View of the Lower Fall at Portage.

Plate XLII. THE FLUME AT THE LOWER PORTAGE FALL.

LOWER PORTAGE FALL.

Plate XLIII. CATHEDRAL ROCK AT THE LOWER PORTAGE FALL

Plate XLIV. Escarpment of Rock below Middle Falls, Showing Horizontal Stratification

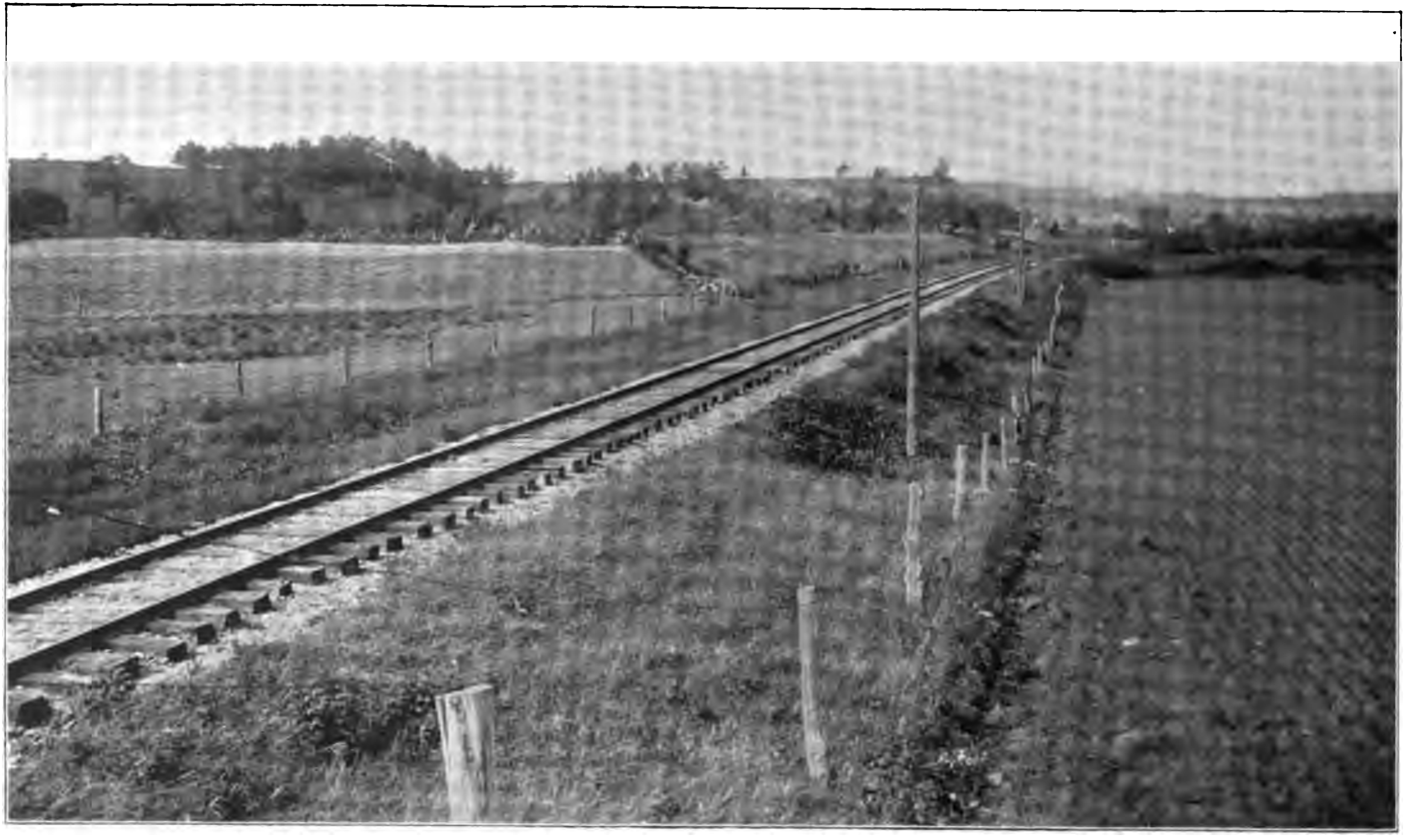


Plate XLV. Early and Later Benches of Ancient Genesee Lake South of Fillmore.

Plate XLVI. View of East Side of Genesfe Gorge at Site of Proposed Portage Dam.

Plate XLVII. View of the Front of the Furens Dam—Also Showing Stairway, and New Channel for River on Left Side of Reservoir.

Plate XLVIII. View of the Furens Dam from above—the Village of Rochetaillee in the Distance.

Plate XLIX. View of the Furens Dam from above—with Water Drawn Well Down.

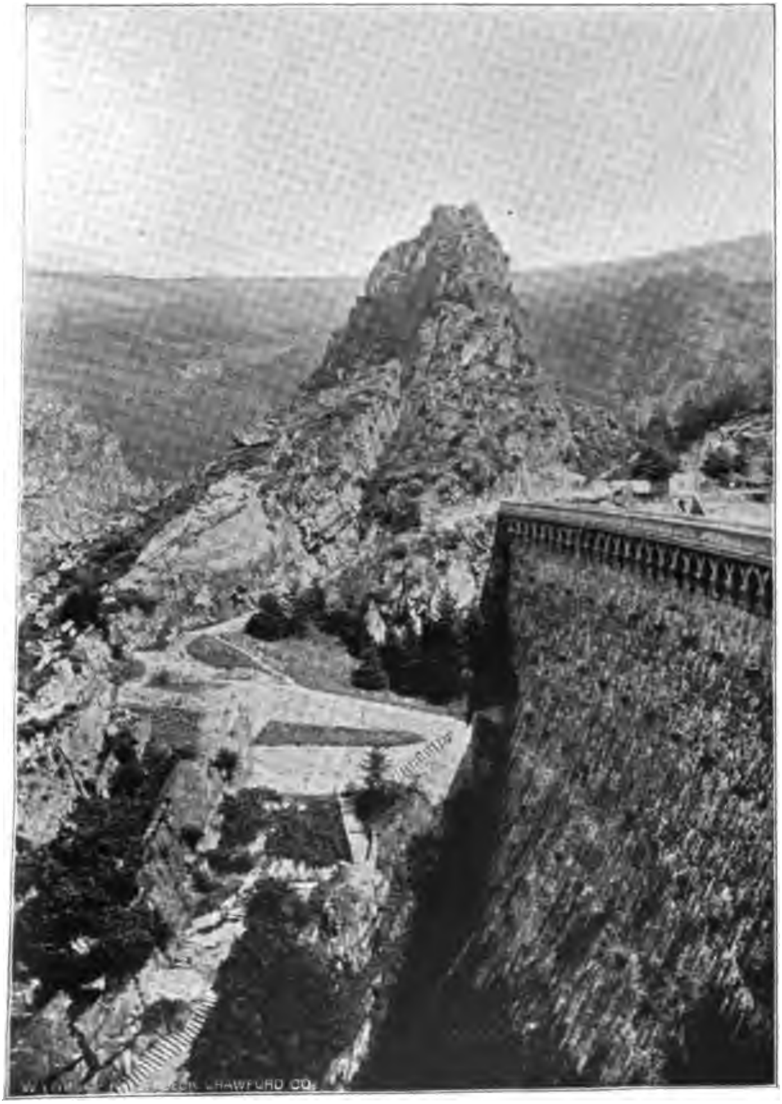


Plate L. View of Front of Furens Dam from End.

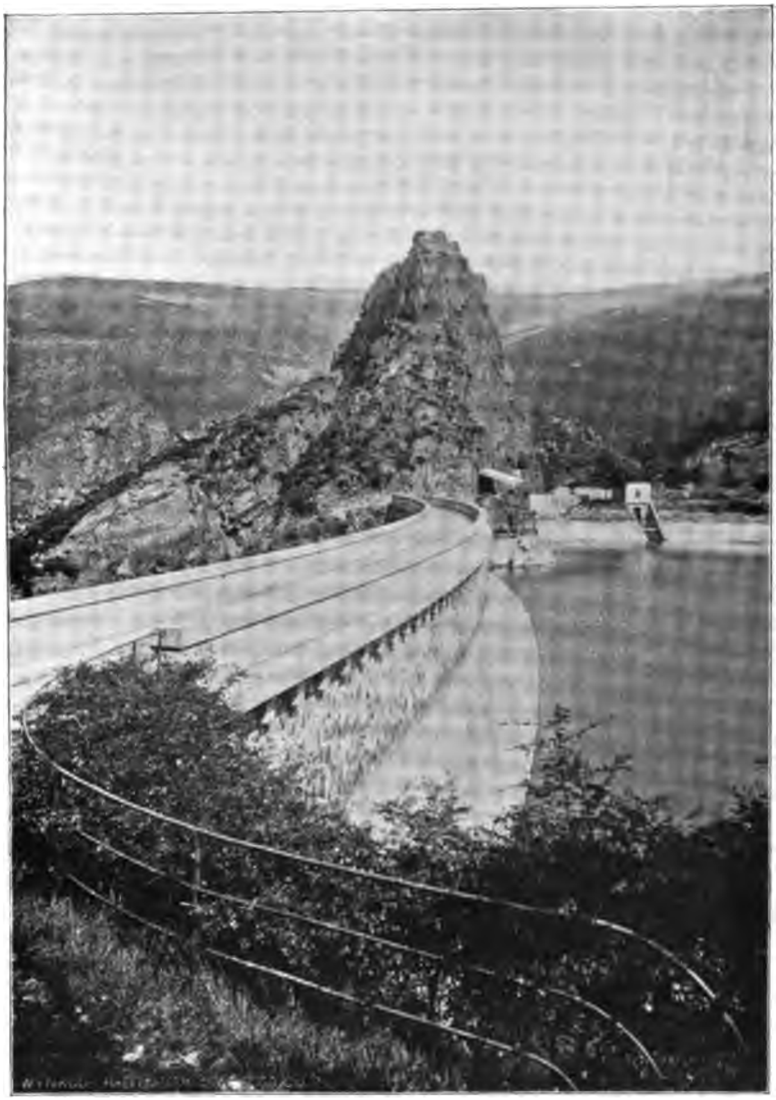


Plate LI. View of Back of Furens Dam from End.

Plate LII. Regulating Works at Head of Furens Reservoir (Les Vannes au Pas-de-Riot).

Plate LIII. The Valley of the Vyrnwy River before the Construction of the Dam.

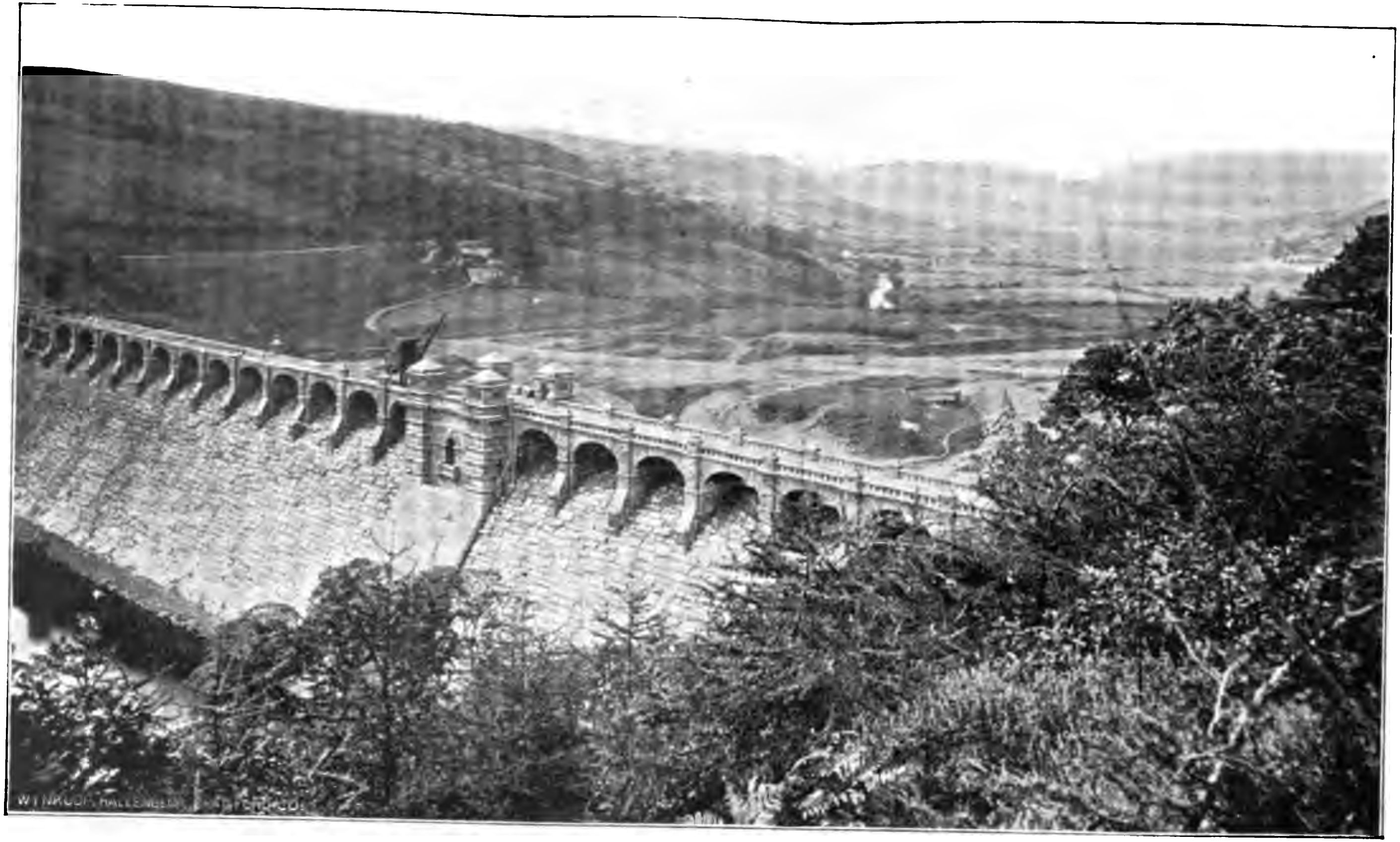


Plate LIV. Vyrnwy Dam and Valley before Filling Reservoir.

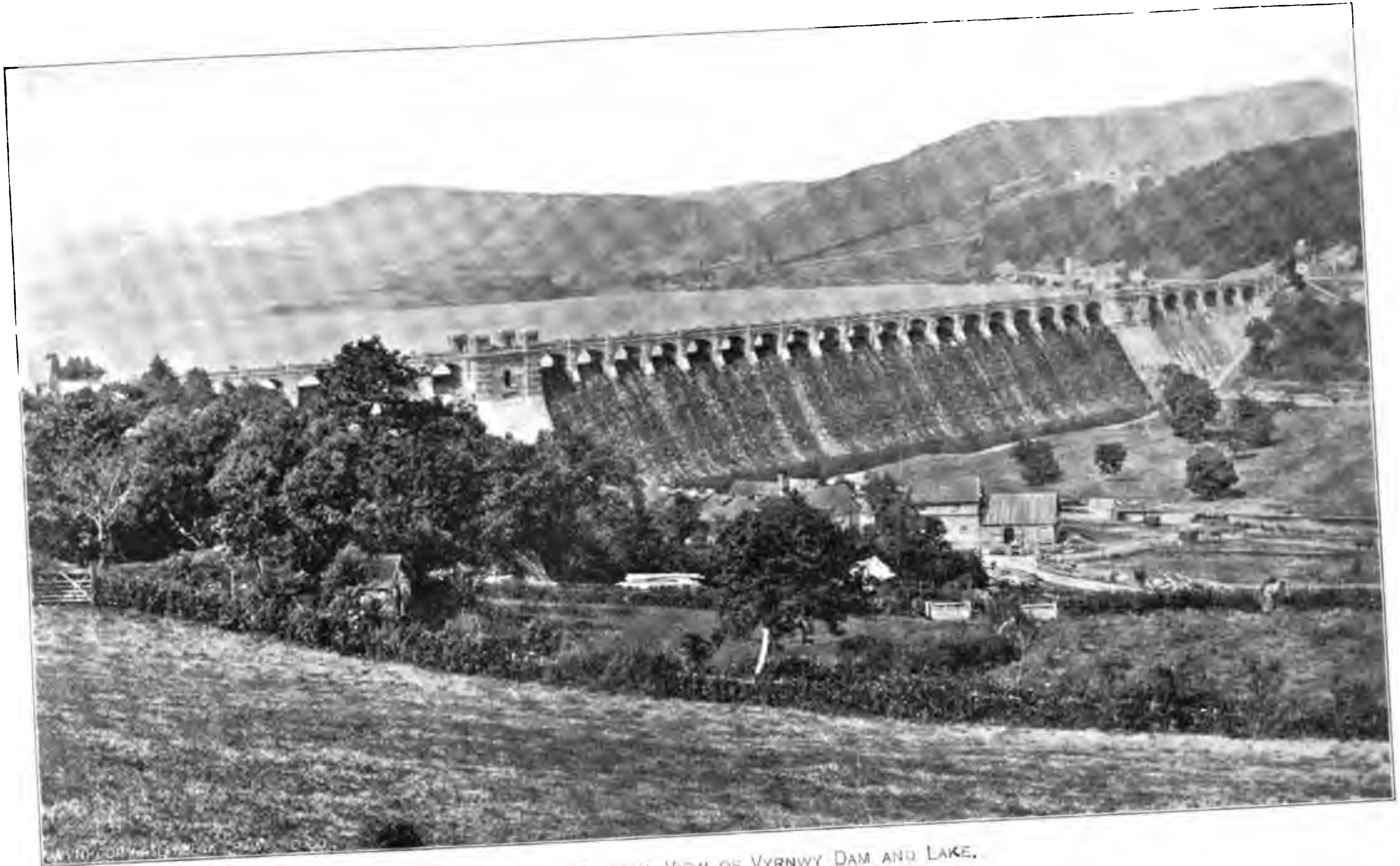


Plate LV. General View of Vyrnwy Dam and Lake.

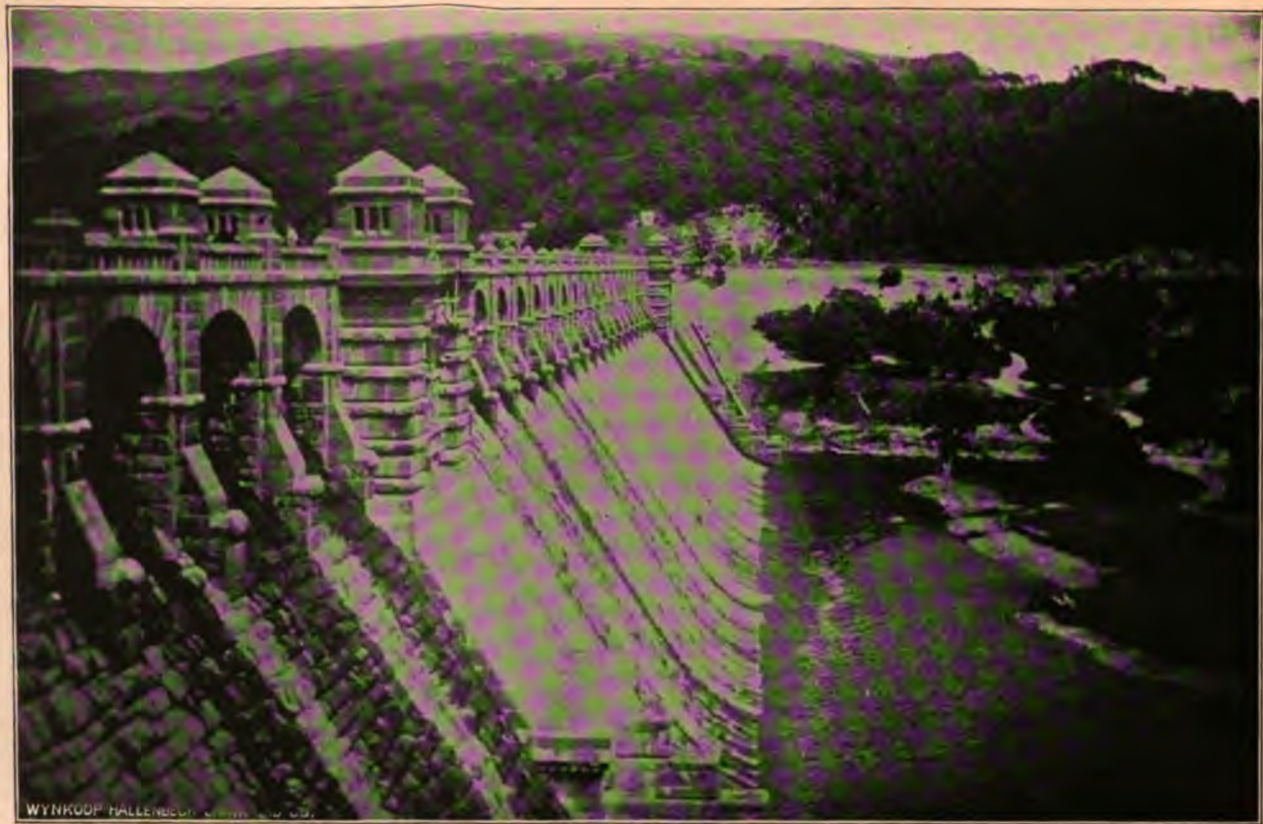


Plate LVI. THE VYRNWY DAM WITH WATER FLOWING OVER THE FRONT FACE.

Plate LVII. View of the Vyrnwy Dam while under Construction.

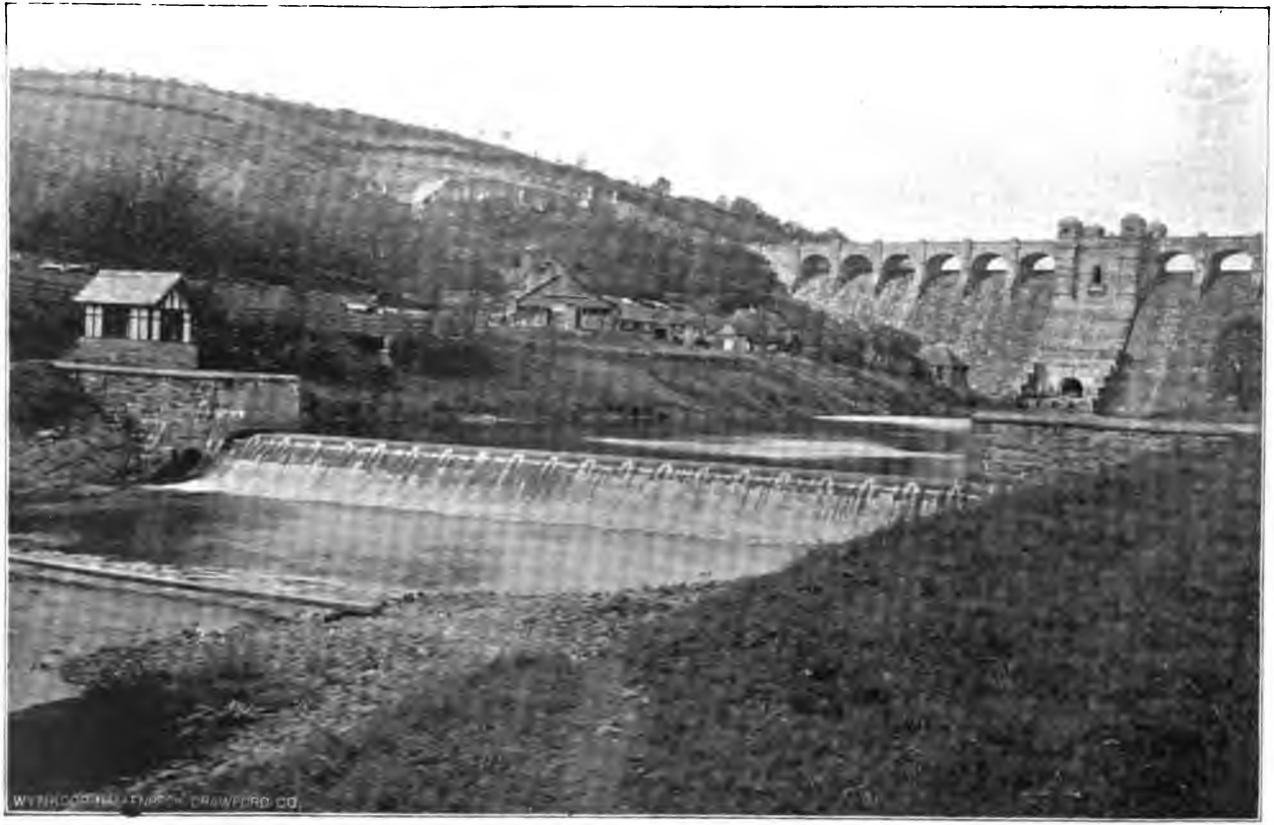


Plate LVIII. Weir on the Vyrnwy River just below Dam.

Plate LIX. INLET GATE HOUSE AT VYRNWY LAKE.

Plate LX. View of Road Around Lake Vyrnwy—taken before Flooding Reservoir.

Plate LXI. View of Head of Lake Vyrnwy Showing Roadway.

Plate LXII. Another View of Lake Vyrnwy Road—taken before Flooding Reservoir.

Plate LXIII. View of Roadway Leading to Vyrnwy Dam.

Plate LXIV. Bridge on the Lake Vyrnwy Roadway.

Plate LXV. View of the Dam of the Manchester Water Works at Lake Thurlmere.

Plate LXVI. Another View of the Dam at Lake Thurlmere.

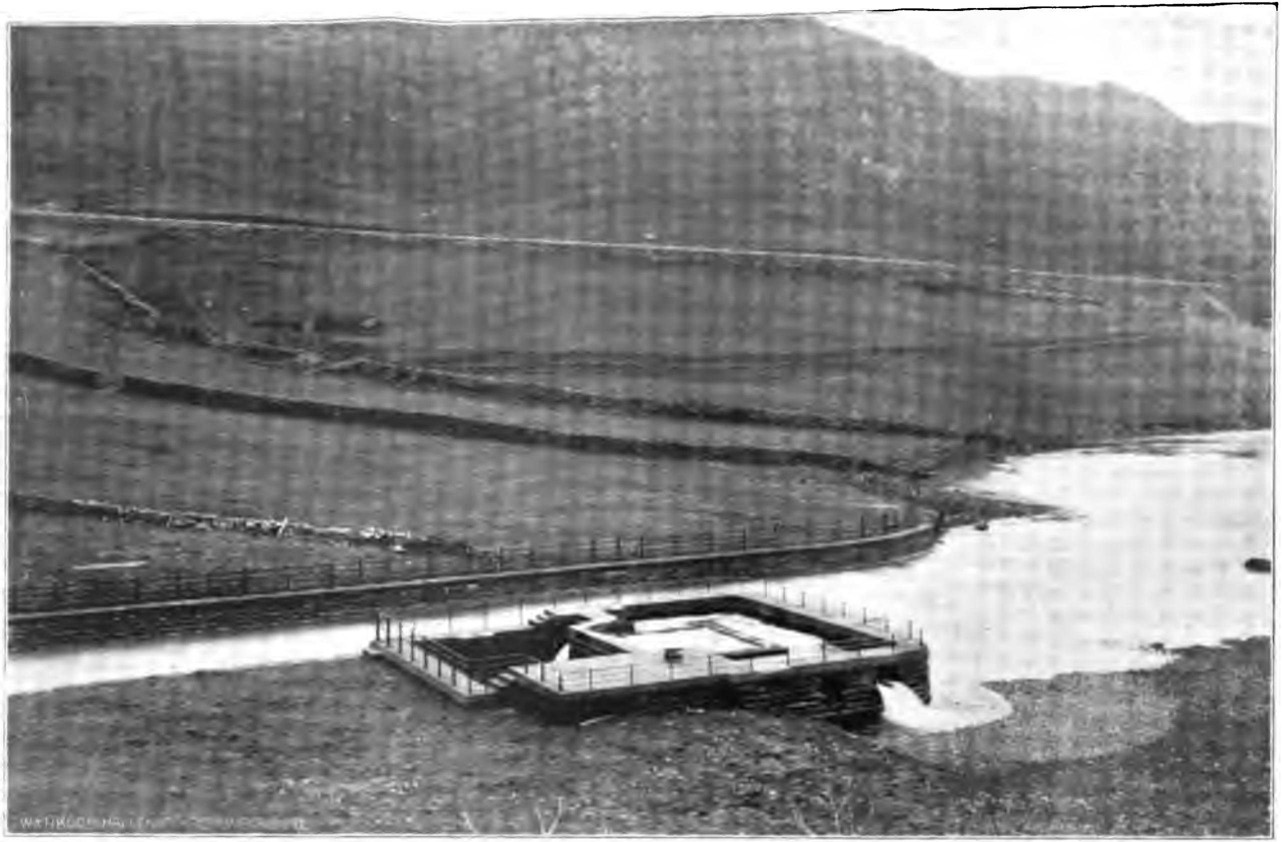


Plate LXVII. VIEW OF CATCH BASIN AT LAKE THURLMERE DAM—SHOWING ITS LOCATION AT FOOT OF PAVED WASTE WAY.

Plate LXVIII. Overflow Weir at Mouth of Waste Way Tunnel, Lake Thurlmere.

Plate LXIX. View of Paved Waste Way at Lake Thurlmere Dam.

Plate LXX. View of Coursed Masonry of Upstream Face of Lake Thurlmere Dam.

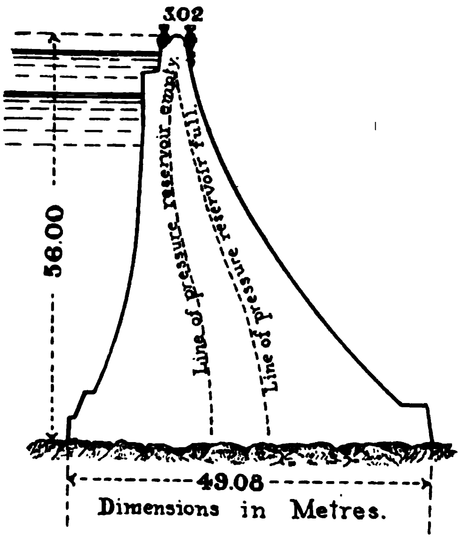


Fig. 1. SECTION OF FURENS DAM.

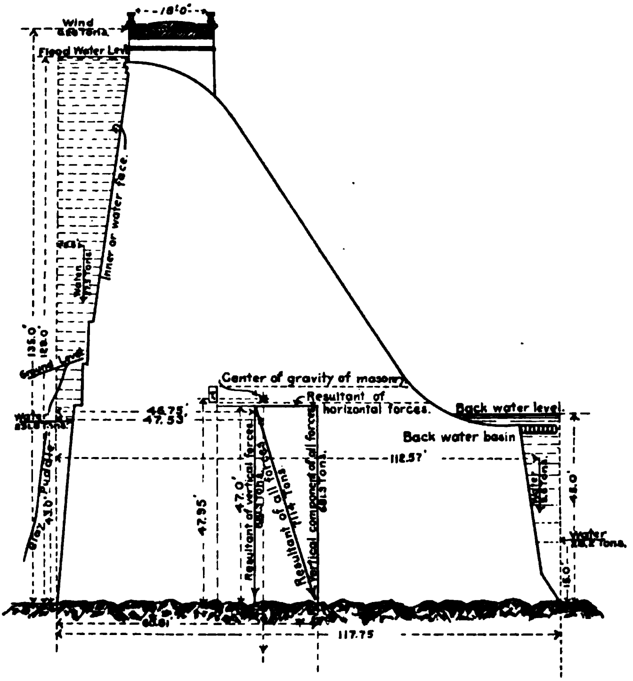


Fig 2. SECTION OF VYRNWY DAM.

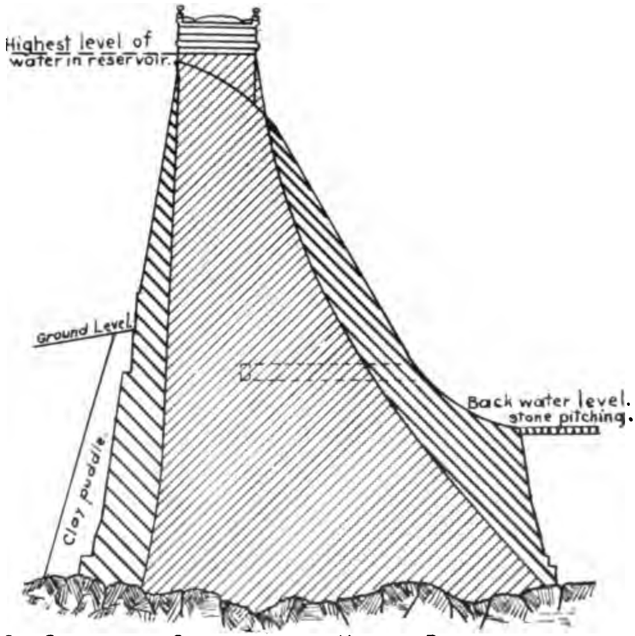


Fig. 3. COMPARATIVE SECTION OF THE VYRNWY DAM AND THE SO-CALLED "ECONOMIC SECTIONS."

Fig. 4. Discharge Tunnel and one of the Ornamental Towers of the Vyrnwy Dam.

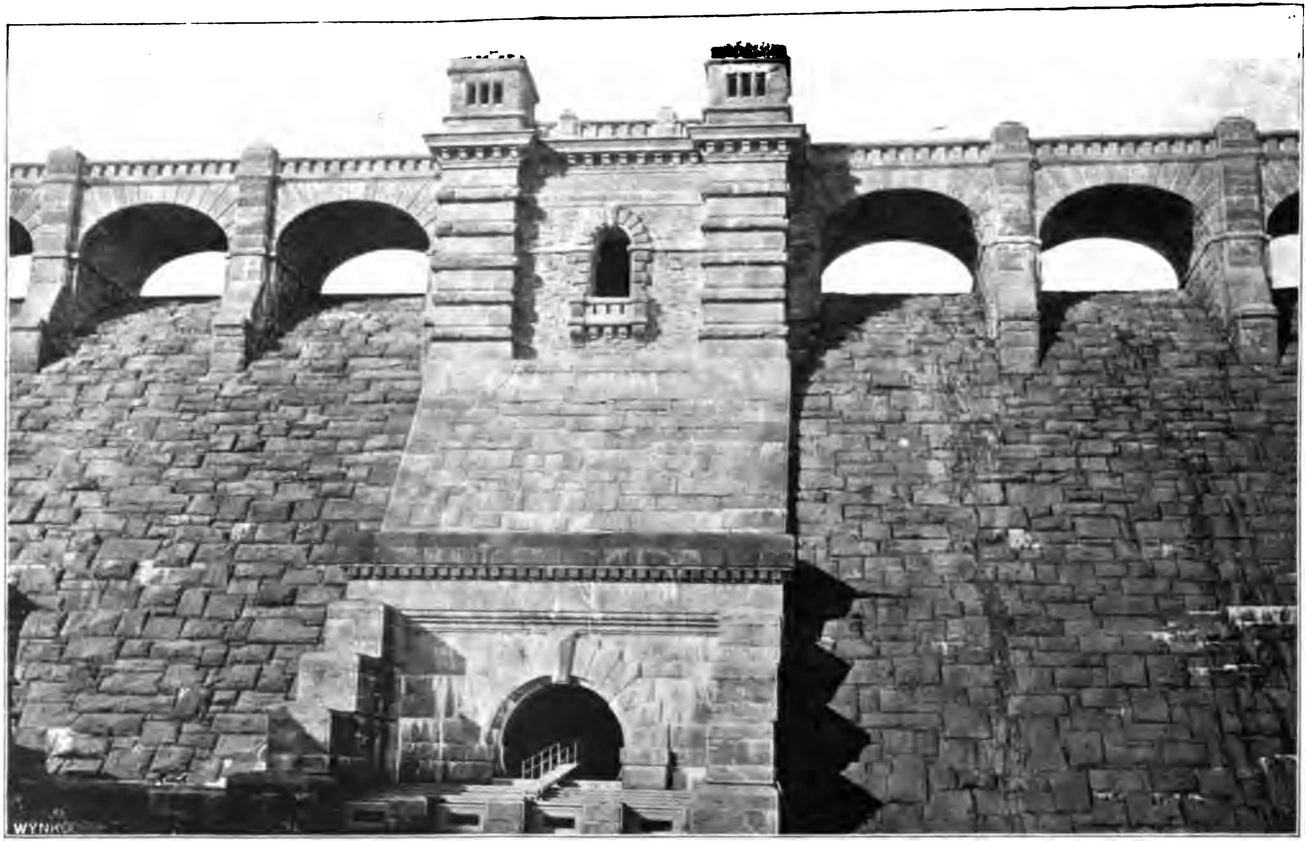


Fig. 4. Discharge Tunnel and one of the Ornamental Towers of the Vyrnwy Dam.

Fig. 5. View of End of Vyrnwy Dam Showing Gage House to Left of Center of Picture.

Fig. 6. VIEW OF END OF VYRNWY DAM SHOWING CATCH GUTTER.

Fig. 7. View of Upper End of Tunnel through Vyrnwy Dam before Insertion of Discharge Pipes and Brick Bulkheads.

Fig. 8. View of Supporting Arches of Roadway across Vyrnwy Dam from Upper Side.

Fig. 9. View of Roadway across Vyrnwy Dam.

Fig. 10. Detail View of Catch Basin at Lake Thurlmere.

Fig. 11. Down Stream Portal of Waste Way Tunnel at Lake Thurlmere.

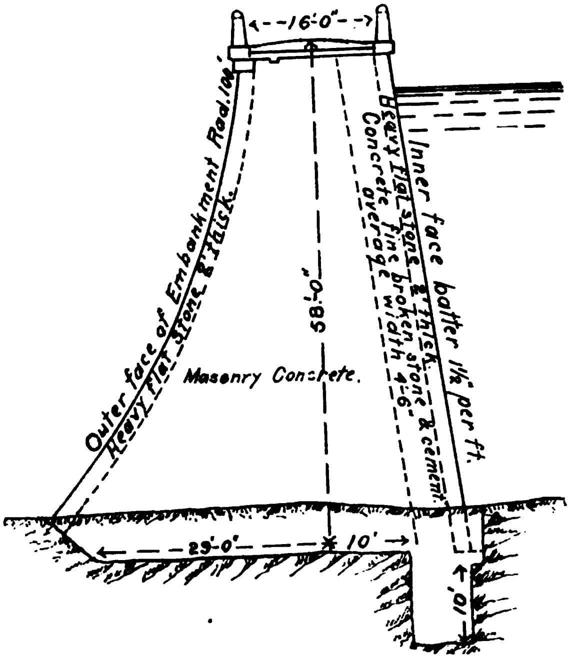


Fig. 12. SECTION OF DAM AT LAKE THURLMERE.

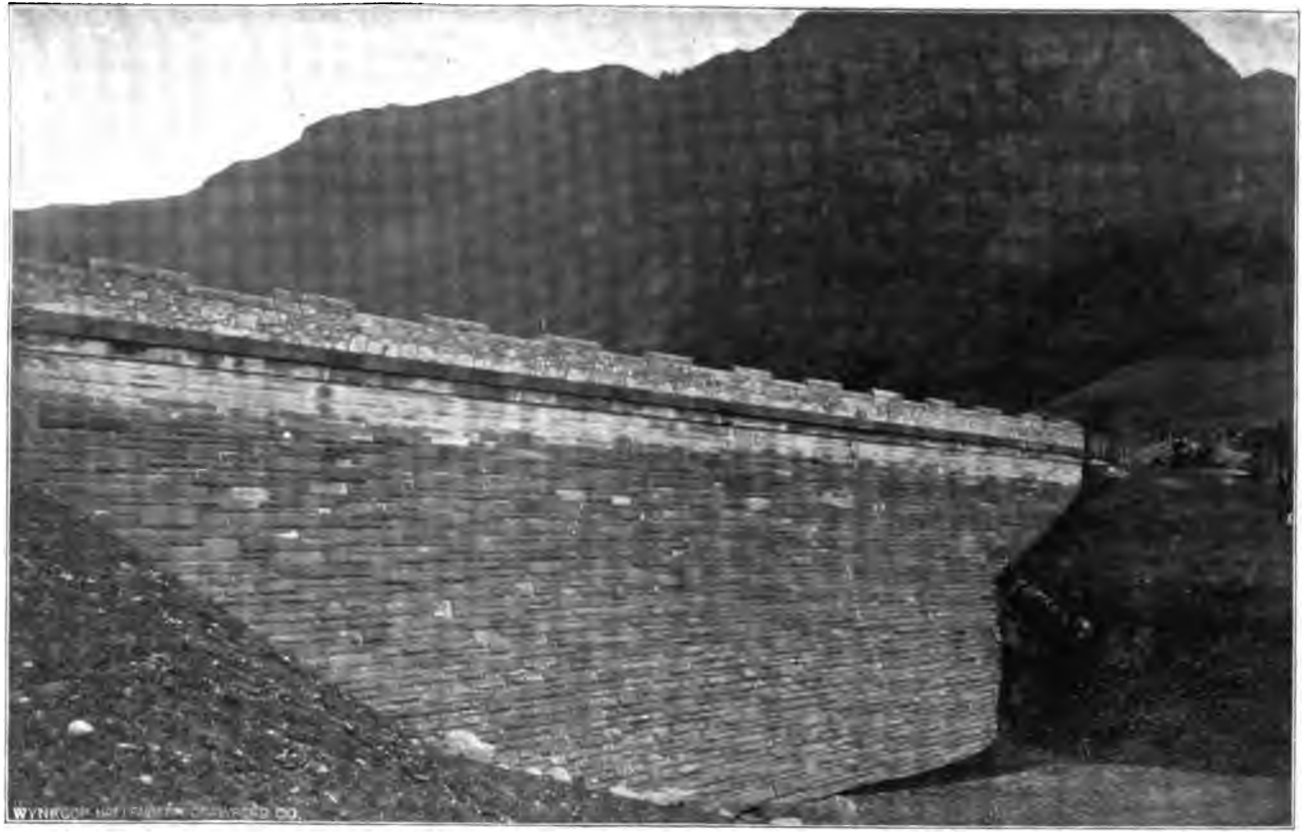


Fig. 13 View of Downstream Face of Wall showing Quality of Masonry at Lake Thurlmere Dam.

Fig. 14. Another View of Downstream Face of Lake Thurlmere Dam.

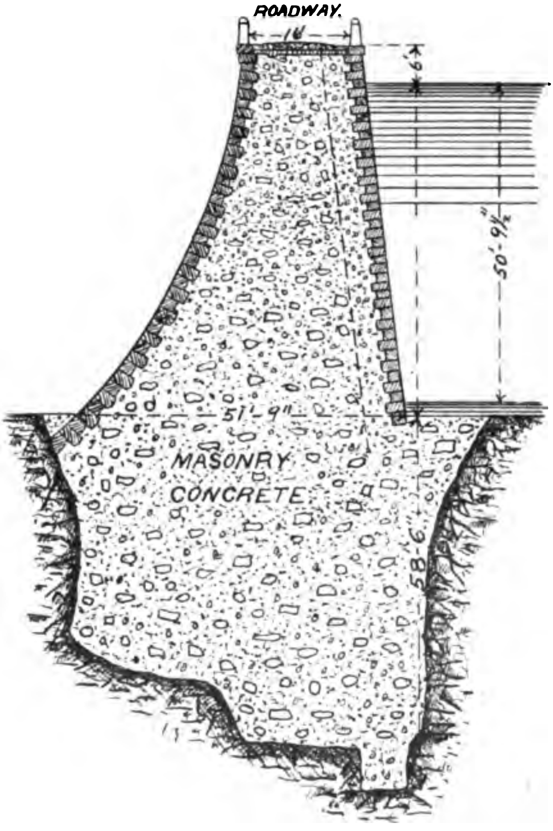


Fig. 15. SECTION OF LAKE THURLMERE DAM—SHOWING METHOD OF CONSTRUCTING FOUNDATION.

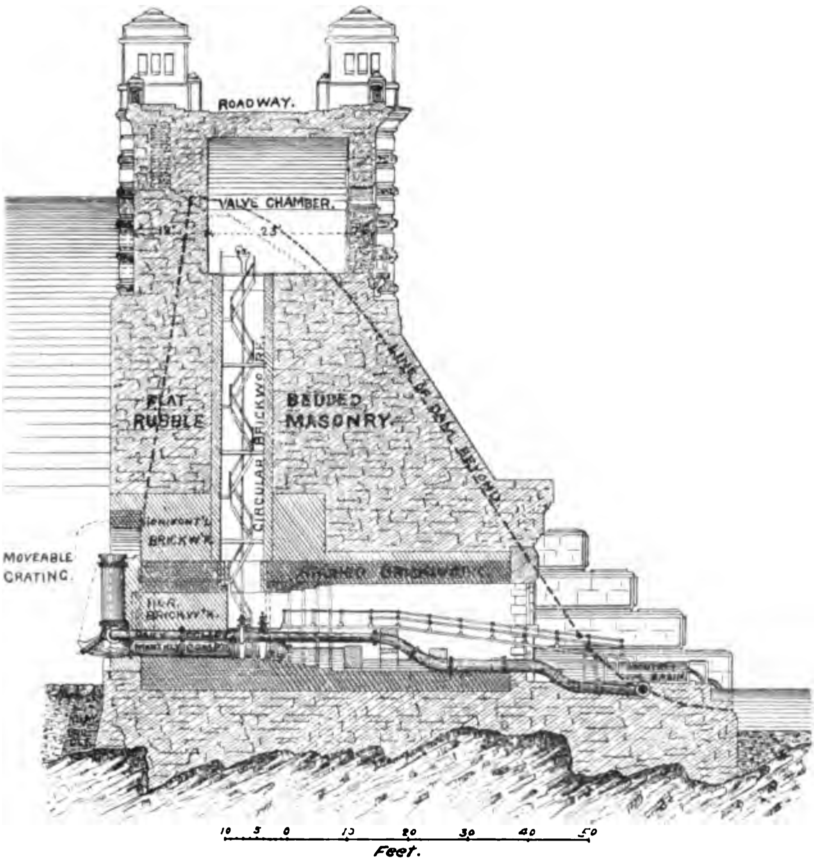


Fig. 16. SECTION OF VYRNWY DAM SHOWING FILLING CHAMBERS, VERTICAL PASSAGEWAY AND DISCHARGE PIPES AS LAID THROUGH TUNNELS.

APPENDIX VIII.

HUDSON RIVER STORAGE.

By George W. Rafter.

Second Report on Survey of Upper Hudson Valley.

ALBANY, N. Y., *February* 1, 1897.

Honorable CAMPBELL W. ADAMS, *State Engineer and Surveyor*, and Honorable GEORGE W. ALDRIDGE, *Superintendent of Public Works:*

Gentlemen.—The undersigned herewith reports as follows, relative to progress on the survey of the Upper Hudson river valley during the year 1896.

In the first report on this survey, which appears in the annual report of the State Engineer and Surveyor for the fiscal year, ending September 30, 1895, I have given a general view of the whole question with such data as were available at the date of that report. In the present report, it is proposed to set forth the additional data gathered during the year 1896, as well as such conclusions as can be immediately drawn therefrom. Certain general data in regard to stream flow of value in the discussion are also included.

SURVEY WORK IN 1896.

Early in the month of June, 1896, a survey party was placed in the field for the purpose of continuing the detailed examination of sites for dams begun last year. The season's work included a detailed survey at Tumblehead Falls with reference to the dam controlling the proposed Schroon valley reservoir; at Hadley, with reference to the proposed main dam on the Hudson river; also of dam sites at Tahawus, Lake Henderson, at the so-called Lester dam on the Boreas river, two locations at Boreas pond, two locations at Newcomb, and a complete survey of the site at Indian lake of which partial surveys were made last year.

In the meantime, the topographical surveys of the region, as carried on by joint arrangement with the United States Geological Survey, have been in progress and have included the completion of

TABLE No. 1.

Runoff data of the Hudson River for the year 1896.

MONTH.	FORT EDWARD.*		MECHANICVILLE.		WARRENSBURGH.	
	Mean daily flow in cubic feet per second.	Total monthly flow in inches on tributary watershed.	Mean daily flow in cubic feet per second.	Total monthly flow in inches on tributary watershed.	Mean daily flow in cubic feet per second.	Total monthly flow in inches on tributary watershed.
	(1)	(2)	(3)	(4)	(5)	(6)
December	4,630	1.91	10,889	2.79	1,233	2.61
January	5,324	2.14	6,7[illegible]7	1.74	2,779	5.8[illegible]
February	2,236	0.86	4,668	1.12	516	0.9[illegible]
March	7,737	3.19	18,600	3.49	1,664	3.52
April	18,785	7.48	24,972	6.20	3,280	6.71
May	2,702	0.70	4,610	1.18	728	1.54
Mean and total	6,902	16.28	10,921	16.52	1,700	21.35
June	3,046	1.21	4,738	1.18	827	1.65
July	1,995	0.82	2,772	0.72	276	0.5[illegible]
August	1,251	0.52	2,442	0.63	265	0.56
Mean and total	2,097	2.55	3,317	2.53	456	2.[illegible]
September	1,347	0.54	2,879	0.71	215	0.44
October	2,424	1.00	4,106	1.05	330	0.7[illegible]
November	7,000	2.79	11,352	2.82	1,069	2.3[illegible]
Mean and total	3,590	4.33	6,112	4.58	545	3.[illegible]
Yearly mean and total	4,873	23.16	7,818	23.63	1,100	27.45

two entire sheets and a portion of a third one. It is exceedingly important that this topographical work should be pushed to completion another season, as without it, the final details, as to drainage area and flowage, can not well be given. The present season's work has developed the fact that, in addition to the sites for reservoirs discussed in the previous report, there is also a good site on the Goodenow river, a short distance above where that stream joins the Hudson, together with an excellent site on the main Hudson, a short distance below the mouth of the Goodenow. The incomplete state of the topographical work renders the discussion of these additional sites, in detail, impossible at the present time.

In regard to the proposed dam at Tumblehead Falls, it may

*The Fort Edward record is subject to revision.

be stated that the surveys of the present season indicate a ledge of hard granitic rock on the north side of the stream substantially as indicated by the photographs illustrating the Tumblehead Falls site, and facing page 142, in the 1895 report. Under the river the soundings indicate solid foundation at a depth generally of from ten to fifteen feet below the river. At the point of greatest depth the solid foundation is found twenty-four feet below the ordinary low water surface of the stream. On the south side the conditions are quite different from those existing on the north side. Several test pits were sunk to the depth of from eighteen to thirty-five feet below the surface, going down through soil, gravel, coarse building sand, boulders, etc., to hard material. In the absence of other than ordinary digging tools it was impossible to carry this part of the investigation to a final solution. The indications were, however, that hard material satisfactory for a foundation exists on this side only at considerable depth. In order to investigate this part of the problem thoroughly it will be necessary to use mechanical sounding and boring arrangements, which could not be used during the past season because the expense of the same would have exceeded the limits of the appropriation. It is hoped if this work is continued another season to make some further investigation of this part of the problem at Tumblehead Falls. The large storage to be gained here, at small expense per unit volume, will justify, it is believed, a fairly complete investigation of this site. A topographical map at a scale of 100 feet to the inch has been prepared showing the topography of the proposed site in considerable detail, but in view of the impossibility of reaching final conclusions this year, it has not been deemed advisable to include the map as part of this report.

Detailed surveys were also made at Hadley, with the result of showing the feasibility of constructing a dam at that site substantially as proposed in the previous report. On making a complete map of the locality it was found that considerably more village property would fall within the limits of the proposed reservoir than was included in the general estimates of the previous report. It was also found that the river is much deeper on the line of the proposed

dam than stated by parties presumably familiar with it when the general investigations were made. Hence it is probable that the cost of the Hadley reservoir will be somewhat greater than assumed

TABLE No. 2.

*Precipitation and mean temperature at Saranac Lake for years 1894 to 1896, inclusive.**

(Precipitation in inches.)

MONTH.	1894.		1895.		1896.		MEANS.	
	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Temperature.	Precipitation.
December	†20°.6	†5.75	21°.0	2.27	22°.9	3.49	21°.5	3.84
January	19°.9	2.77	14°.6	1.84	11°.7	1.11	15°.4	1.91
February	13°.4	1.96	10°.2	1.22	15°.1	4.28	12°.9	2.49
March	32°.0	2.04	19°.6	1.37	17°.7	4.31	23°.4	2.57
April	41°.7	0.75	38° 9	2.30	40°.2	1.37	40°.3	1.47
May	55°.3	4.41	57°.6	4.34	58°.1	2.47	57°.0	3.74
Mean and total	30°.6	17.68	27°.0	13.34	27°.6	17.03	28°.4	16.02
June	64°.8	5.06	67°.0	3.25	62°.0	3.70	64°.6	4.00
July	66°.3	3.44	63°.0	2.46	66°.8	4.19	65°.4	3.36
August	60°.7	1.58	62°.6	4.61	65°.5	2.68	62°.9	2.96
Mean and total	63°.9	10.08	64°.2	10.32	64°.8	10.57	64°.3	10.32
September	60°.0	3.58	57°.2	3.56	54°.5	4.75	57°.2	3.96
October	46°.5	4.10	39°.2	1.68	41°.7	1.76	42°.5	2.51
November	27°.6	2.75	33°.0	4.43	35°.8	2.80	32°.1	3.33
Mean and total	44°.7	10.43	43°.1	9.67	44°.0	9.31	43°.9	9.80
Yearly mean and total	42°.5	38.19	40°.3	33.33	41°.0	36.91	41°.2	36.14

in the former report, but even at much greater cost this reservoir is still, in view of the regulation it will afford, an exceedingly cheap one and a necessary part of the reservoir system when carried out. The topographical work has not yet been extended over the area to be flooded, which makes it impossible to give the final figures as to this reservoir at this time. Hence, the detailed surveys of the dam site and plans of dam are not presented with this report.

The incomplete state of the topographical surveys also renders it impossible to give final consideration to the reservoirs at Tahawus, Lake Henderson, Boreas river and Newcomb.

* From reports of State Weather Bureau. † Mean of the Northern Plateau.

Detailed plans for the proposed dam at the foot of Indian lake have been partially prepared, and while the final data as to catchment area to be derived from the topographical survey are still lacking in the case of this reservoir, yet the plans are so nearly completed that, if desirable, an appropriation could be made for the construction of the proposed Indian lake reservoir at once. It is considered in the case of this reservoir that the computations as to drainage area are sufficiently exact to justify constructing the reservoir, if desired, without waiting for the completion of the topographical survey. The area to be flooded was accurately determined by a survey of the lake as made by Mr. Greenalch in 1895, and as shown by Plate IX, of the 1895 report. Taking Plate IX,

TABLE No. 2 A.

Precipitation at Kings Station, Saratoga county, for 1891 *to* 1896, *inclusive.**

(In inches.)

MONTH.	1891.	1892.	1893.	1894.	1895.	1896.	Mean.
December	†2.85	4.96	1.45	4.52	3.06	4.12	3.49
January	†3.95	5.41	2.90	3.06	2.16	1.15	3.11
February	†5.61	2.30	6.85	3.15	1.20	6.20	4.22
March	3.15	2.25	2.65	2.17	2.01	6.40	3.10
April	1.90	0.84	3.18	1.87	6.52	0.70	2.50
May	2.57	6.21	6.06	5.26	2.26	3.47	4.31
Total	20.03	21.97	23.09	20.03	17.21	22.04	20.73
June	2.47	4.49	1.52	5.11	3.40	2.21	3.20
July	4.04	4.31	5.11	3.63	3.65	4.30	4.17
August	3.93	6.66	11.25	3.14	3.86	2.19	5.17
Total	10.44	15.46	17.88	11.88	10.91	8.70	12.54
September	1.68	2.39	3.65	2.82	2.27	6.79	3.26
October	2.60	1.30	1.97	4.72	1.46	4.25	2.72
November	2.98	3.12	1.25	2.74	3.23	6.17	3.25
Total	7.26	6.81	6.87	10.28	6.96	17.21	9.23
Yearly total	37.73	44.24	47.84	42.19	35.08	47.95	42.50

in conjunction with the plans of dams referred to in the foregoing and we may consider the plans of Indian lake reservoir as complete. General plans have also been prepared of the reservoir on the Boreas river and at Boreas pond.

*From Reports of State Weather Bureau. †Galway Record.

THE 1896 STREAM GAGINGS.

It is stated at page 118 of the 1895 report that arrangements have been made not only to continue the Mechanicville gagings, but also to have a similar series made at Troy, Fort Edward, Sandy Hill and Hadley, on the main river, at Conklinville, on the Sacandaga river, and at Warrensburg, on the Schroon. On investigation, however, it appeared evident that the leakage of the State dam, at Troy, was so great as to seriously interfere with the accuracy of any gagings that might be made at that point. Gagings have, however, been made at Fort Edward, Sandy Hill, Hadley, Conklinville and Warrensburg. The gagings at Sandy Hill have been taken merely as a check on those at Fort Edward, and for lack of time have not yet been worked up. During the flood of January, 1896, the gage at Hadley was carried away, and the record necessarily discontinued at that place until the time of low water later in the season. In addition to Mechanicville the record for Fort Edward and Warrensburg is given in Table No. 1. The observations at Conklinville have not yet been reduced. Table No. 1, gives

TABLE No. 2 B.

*Precipitation at Easton, Washington county, for months indicated, from 1890 to 1896.**

(In inches.)

MONTH.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
December	......	3.49	4.82	0.74	......	1.99	2.01
January	......	4.15	3.81	1.10	......	1.48	0.75
February	......	4.18	2.02	4.56	......	0.99	4.61
March	......	3.12	1.79	1.91	......	......	4.58
April	......	2.80	0.82	3.11	......	......	....
May	......	2.42	6.85	3.89	......	......	....
Total	......	20.16	20.11	15.31	......	......	....
June	......	2.65	5.57	3.68	......	......	....
July	......	3.40	4.34	5.45	......	......	5.76
August	5.94	3.11	5.32	12.48	......	......	3.[illegible]8
Total	......	9.16	15.43	21.61	......	......	....
September	6.79	1.07	2.32	5.08	......	......	5.30
October	5.65	2.49	1.71	2.45	......	......	3.17
November	2.30	3.14	2.50	1.16	......	4.98	4.30
Total	14.74	6.70	6.53	8.69	......	......	12.77
Yearly total	......	36.02	42.07	45.61	......	......	....

*From reports of State Weather Bureau.

the results of the gagings at Mechanicville, Fort Edward and Warrensburg for the water year of 1896. From Columns (2), (4) and (6) of this table, giving inches on the watershed, we learn that at Warrensburg the runoff for the storage period was 21.25 inches; for the growing period, 2.83 inches, and for the replenishing period, 3.37 inches. At Fort Edward, the runoff for the storage period was 16.28 inches, and at Mechanicville, 16.52 inches. For the growing period, 2.55 inches at Fort Edward, and 2.53 inches at Mechanicville. For the replenishing period, 4.33 inches at Fort Edward and 4.58 inches at Mechanicville. The totals for the water year are: Fort Edward, 23.16 inches, and Mechanicville, 23.63 inches, and Warrensburg, 27.45 inches. Taking into account the storage period only, it appears that the total runoff from the Schroon area above Warrensburg was from 4.75 to 5.00 inches greater than the runoff at either Mechanicville or Fort Edward. The effect of the large storage on Schroon and Brant lakes is strikingly shown by the runoff at Warrensburg of 1.54 inches for the month of May, which was a dry month throughout the Upper Hudson area, in comparison with 0.70 inches at Fort Edward and 1.18 inches at Mechanicville. The effect of this large storage is also apparent in the month of June when the runoff was 1.69 inches at Warrensburg and 1.21 inches at Fort Edward and 1.18 inches at Mechanicville.

METEOROLOGICAL DATA AT SARANAC LAKE.

In Table No. 2, we have the precipitation and mean temperature at Saranac lake for the years 1894 to 1896, inclusive, as derived from the monthly reports of the State weather bureau. While Saranac lake is not in the Upper Hudson drainage area, it is only a short distance to the north of it, and the record kept there may be considered as giving a fair index of the meteorological conditions prevailing on the northern part of the Hudson area. The elevation of Saranac lake is 1,488 feet above tide.*

*As derived from the levels of the Chateaugay railroad. Bulletin of the U. S. Geological Survey, No. 76. A Dictionary of Altitudes in the United States.

TABLE No. 2 C.

Precipitation at Gloversville, Fulton County, N. Y., from 1892 *to* 1896.*

(In inches.)

MONTH.	1892.	1893.	1894.	1895.	1896.	Mean.
December	....	1.34	4.33	3.04	2.91	2.90
January	....	1.64	3.27	2.86	1.47	2.31
February	....	6.81	3.19	1.19	5.90	4.27
March	....	1.84	2.38	2.08	6.59	3.22
April	...	3.57	2.74	4.48	0.96	2.94
May	7.90	6.06	7.48	2.05	3.19	5.34
Total	....	21.26	23.39	15.70	21.02	20.98
June	4.91	1.95	4.95	3.19	3.79	3.76
July	3.27	2.69	3.06	3.41	4.95	3.48
August	9.23	5.80	1.64	5.15	2.01	4.76
Total	17.41	10.44	9.65	11.75	10.75	12.00
September	3.00	3.94	3.73	1.90	6.21	3.76
October	1.55	1.62	4.93	1.78	3.06	2.58
November	3.29	1.34	3.14	4.88	5.37	3.59
Total	7.84	6.90	11.80	8.46	14.64	9.93
Yearly total	....	33.60	44.84	35.91	46.41	42.91

As shown by Table No. 2, the mean temperature for the years 1894-96, inclusive, is 41.6° F. The precipitation for the storage period of 1894 was 17.68 inches; 13.34 inches for 1895 and 17.03 inches for 1896. The total precipitation for each year was, for 1894, 38.19 inches; 1895, 33.03; and 1896, 36.91 inches.

If we compare these figures with those of Tables Nos. 2 to 4, inclusive, and Tables Nos. 1 to 5, of the first report, for the corresponding years, it is seen that the precipitation of the northern part of the Hudson drainage area is frequently no higher than that for more southerly points.

MISCELLANEOUS METEOROLOGICAL DATA FOR 1896.

In Table No. 3, we have the mean monthly temperature and precipitation for the year 1896, at Albany, Glens Falls and Western Massachusetts, as represented by the Williamstown record; also that of the Northern Plateau, etc. The total precipitation at Albany is 29.74 inches for the whole year, while at Glens Falls it was 43.82 inches. At King's station the total for the year, as

*From reports of State Weather Bureau.

shown in Table No. 2 A, was 47.95 inches. At Williamstown, which we have taken as representing the Western Massachusetts precipitation, the total for the year was 31.66 inches. It is clear from the preceding record that we must seek further for an explanation of why the runoff for the water year 1896, was considerably greater

TABLE No. 3.

Mean temperature and precipitation at Albany, Glens Falls, Western Massachusetts and the Northern Plateau for the year 1896.

(Precipitation in inches)

MONTH.	ALBANY.		GLENS FALLS.		WESTERN MASSACHUSETTS.		NORTHERN PLATEAU.	
	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.
December	31°.9	2.59	27°.3	3.73	29°.9	3.11	26°.0	4.18
January	20°.2	0.98	17°.7	1.08	20°.4	0.71	14°.7	2.25
February	24°.8	4.03	20°.8	5.41	24°.0	2.29	17°.9	6.36
March	27°.1	4.66	24°.8	6.52	26°.3	3.60	19°.9	5.56
April	50°.2	0.98	47°.2	1.20	47°.8	0.77	43°.3	1.19
May	63°.6	1.55	59°.1	1.53	60°.9	2.22	58°.1	2.68
Mean and total	36°.3	14.79	32°.8	19.47	34°.9	12.70	30°.0	22.17
June	67°.7	2.49	64°.6	3.01	64°.0	2.55	61°.6	2.87
July	74°.2	3.57	*69°.5	4.53	70°.9	2.65	67°.7	4.80
August	72°.6	2.25	68°.7	2.80	67°.4	3.06	65°.8	2.58
Mean and total	71°.5	8.31	67°.6	10.34	67°.4	8.26	65°.0	10.25
September	62°.2	3.31	58°.9	4.81	58°.8	4.82	55°.8	5.24
October	48°.4	1.53	45°.4	3.65	45°.5	2.94	42°.7	2.85
November	44°.0	1.80	40°.2	5.55	42°.3	2.94	37°.5	5.09
Mean and total	51°.5	6.64	48°.2	14.01	48°.9	10.70	45°.3	13.18
Yearly mean and total	48°.9	29.74	45°.4	43.82	46°.5	31.66	42°.6	45.60

than that for the water year 1895. A part of the explanation may be found by considering the precipitation of the Northern Plateau as a whole. Referring to Table No. 3, we learn that the precipitation of the Northern Plateau for the storage period of 1896, was 22.13 inches; for the growing period, 10.25 inches, and for the replenishing period, 13.18 inches, giving a total of 45.56 inches. It is probable, if we had the record of runoff of the Sacandaga river

* Not in record. Mean of Champlain Valley used.

available, that we would find the yield of that stream for the water year of 1896 very large. By way of proving this proposition we may refer to the Gloversville precipitation record as given in Table No. 2 C, from which it appears that the total for the storage period, was 21.02 inches; for the growing period 10.75 inches, and for the replenishing period, 14.64 inches. The total for the year was 46.41 inches. As opposed to the fairly large runoff of the Sacandaga, main Upper Hudson and Schroon, we have the very low rainfall of Western Massachusetts with its consequent resultant probable low runoff of the Hoosic and Battenkill. There is no reason for doubting, that, if we had gagings for all these several divisions of the Hudson drainage area, we would find them essentially in accord with the indications of the precipitation records. In a general way Table No. 1 shows the effect of heavier rainfall of the western part of the drainage area in maintaining stream flow. A further explanation of why the runoff of the stream was up to the average in 1896, may be found by considering that the sequence of precipitation was such in 1895 as to leave full ground water at the beginning of the 1896 water year. This division of the subject will be touched upon further on.

The foregoing discussion as to the yield of different parts of the same drainage area may lead us to consider that the problem of the real relation between the precipitation and runoff of a large drainage area is an exceedingly complicated one, far more difficult than the relation of these elements for small areas. For instance, with areas not exceeding from 50 to 100 square miles it will usually be easy to so locate a single meteorological station as to give a fair index of the mean temperature and precipitation of the whole area, but when the area expands out to one of several thousand square miles, as in the case of the Upper Hudson, it is evident, not only that the indications of a single rainfall station do not apply, but that the indications of several stations may still be insufficient to give the true mean precipitation. For a drainage basin of 4,500 square miles there should probably be at least from fifteen to twenty-five stations properly distributed over the area. In order to find the true mean rainfall, the record of each station

should be apportioned to that proportional part of the entire area to which it fairly applies. In this way we could compute the mean rainfall over the whole area, but in order to obtain complete information as to the relation between precipitation and runoff we would still need to know the runoffs of the several tributary streams, because the runoffs are not always entirely proportionate to the rainfalls. Again, the temperature element exercises so great an influence as to require taking into account. The general meteorological conditions also vary over a wide area. As will be shown further on, the meteorology of the Adirondack region is so far different from that of Albany that the observations at Albany do not apply except in a very general way. We may say indeed that the Northern Plateau of the State Weather Bureau is mostly in a different meteorological belt.

The importance of a knowledge of temperature in relation to precipitation and runoff is pointed out on page 98 of the 1895 report. In order to show such relations clearly, the available temperature records have been compiled and are given herewith. So far as known the temperature records presented in the accompanying tables include about every temperature record which can be considered as in any degree applying. The accompanying tables may also be referred to for the available rainfall records.

THE LAW OF EVAPORATION.

The great practical value of a knowledge of the runoff of streams in relation to meteorological phenomena has been pointed out in the previous report, and by way of systematizing and adding to our knowledge of this important subject, not only in its application to the Upper Hudson, but so far as possible in relation to other streams as well, we will now discuss certain physical phenomena which it is necessary to understand in order to solve the problem in hand. As the first of these we may refer to evaporation. The law of evaporation from water surfaces has been elucidated by various writers, among the more recent of whom we may place Mr. FitzGerald, of the Boston water-works, first.*

*See paper on Evaporation. By Desmond FitzGerald, M. Am. Soc. C. E. Trans. Am. Soc. C. E., Vol. XV. (Sept. 1886), pp. 581-646.

Mr. FitzGerald's formula for evaporation is as follows:

$$E = \frac{(V - v)\left(1 + \frac{w}{2}\right)}{60}$$

In this formula, V means the maximum force of vapor in inches of mercury corresponding to the temperature of the water; v, the force of vapor present in the air; W, the velocity of the wind in miles per hour, and E, the evaporation in inches of depth per hour. It can be shown that there is going on nearly always a condensation of moisture from the air upon any water surface. At the same time there is going on a loss of moisture from the water surface by evaporation. The intensity of both these operations depends upon the difference in temperature between the air and any water surface with which it may be in contact. When the temperature of air and water are the same both processes stop. Evaporation is, therefore, in effect, the measure of the difference of these two exchanges. The experiments of Mr. FitzGerald and others have shown that evaporation from water surfaces is subject to a definite law, expressed by the formula just given, but evaporation from the surface of the ground has never been reduced to any such simple expression. Various difficulties arise which, apparently, render it impossible to make a single expression covering all the phenomena involved. A little reflection will convince one that if the surface of the ground be kept constantly wet, evaporation therefrom will go on substantially as from a water surface. The difficulty in reducing evaporation from the ground to a simple formula is largely due to uncertainty as to the water supply. Thus, while the demands of evaporation from the surface of the ground are continuous, the same as from water surfaces, the constant interruptions, by either complete or partial exhaustion of the available supply, complicates the action so much as to render expression by formula imposible. The demands of vegetation, which vary greatly at different seasons of the year, also come in to further complicate the problem.

TA

Precipitation at Cambridge Washington Academy, Camb

MONTH.	1827.	1828.	1829.	1830.
December	†2.36	4.25	0.43	3.12
January	6.48	2.49	4.10	1.90
February	2.97	2.00	2.25	2.00
March	2.61	1.30	2.40	2.29
April	7.24	1.77	4.85	1.24
May	3.63	4.25	3.77	1.86
Total	25.29	16.06	17.80	12.41
June	4.49	5.36	4.97	5.15
July	5.01	4.91	2.50	3.66
August	4.02	5.54	0.81	1.20
Total	13.52	15.81	8.28	10.01
September	3.66	6.33	3.30	3.50
October	4.72	2.47	3.03	3.35
November	2.93	6.83	3.94	3.35
Total	11.31	15.63	10.27	10.20
Yearly total	50.12	47.50	36.35	32.62

*From State Meteorology.

No. 5.

e, *Washington County, N. Y., from* 1827 *to* 1839, *inclusive.**

hes.)

	1832.	1833.	1834.	1835.	1836.	1837.	1838.	1839.	Mean.
0	2.50	2.51	1.17	1.98	0.92	1.52	2.18	2.10	2.36
0	4.17	1.94	1.41	4.25	6.88	2.70	3.05	2.47	3.36
5	4.16	1.93	1.70	2.15	4.15	3.63	2.55	1.88	2.61
0	3.67	2.09	2.43	2.20	0.96	2.30	0.75	0.95	2.12
0	4.00	1.35	2.58	1.95	2.08	2.90	0.98	9.49	3.36
0	3.30	9.67	2.56	2.65	2.65	4.50	4.04	2.17	3.65
5	21.80	19.49	11.85	15.18	17.64	17.55	13.55	19.06	17.46
0	1.70	3.79	2.74	6.25	3.77	2.80	8.78	7.02	4.66
9	4.35	4.36	2.68	4.48	2.36	2.80	2.46	5.48	3.91
2	6.83	6.74	1.37	5.30	1.66	2.53	8.62	2.31	3.98
1	12.88	14.89	6.79	16.03	7.79	8.13	19.86	14.81	12.55
2	3.32	2.79	3.47	1.10	2.44	1.15	4.10	3.17	3.27
2	4.22	8.35	4.21	2.67	3.10	2.28	3.15	1.10	3.60
5	4.22	3.13	2.05	2.00	2.48	1.80	3.58	2.48	3.29
9	11.76	14.27	9.73	5.77	8.02	5.23	10.83	6.75	10.16
5	46.44	48.65	28.37	36.98	33.45	30.91	44.24	40.62	40.17

†Mean of twelve years.

TABL

Precipitation at Granville Academy, Granville, Washington Co

(In i

MONTH.	1835.	1836.	1837.	1838.	1839.	1840.
December	†2.56	1.17	‡3.90	†2.56	2.55	1.98
January	2.99	2.82	......	1.33	1.79	2.10
February	1.08	3.52	......	0.59	1.35	1.60
March	1.20	0.65	......	0.39	1.66	1.71
April	3.36	2.57	......	0.64	2.08	2.05
May	2.84	3.69	......	4.33	2.96	3.65
Total	14.03	14.42	......	9.84	12.39	13.09
June	4.78	1.90	......	3.46	4.73	4.29
July	3.18	0.63	......	2.30	4.13	1.68
August	5.02	1.72	......	4.33	1.50	3.43
Total	12.98	4.25	......	10.09	10.36	9.40
September	1.53	1.30	......	2.48	2.30	2.50
October	1.79	3.63	......	2.89	1.45	3.79
November	1.96	2.45	......	3.36	2.01	2.18
Total	5.28	7.38	......	8.73	5.76	8.47
Yearly total	32.29	26.05	......	28.66	28.51	30.96

* From State Meteorology. † Mean of thirte

No. 6.

, *N. Y., for the years indicated, from* 1835 *to* 1849, *inclusive.**

.)

1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	Mean.
1.98	1.76	1.67	1.14	1.78	2.83	6.15	5.21	2.48
0.64	0.45	2.46	3.30	2.36	3.03	3.09	0.80	2.03
1.07	1.17	1.03	1.32	1.62	2.32	1.94	1.08	1.42
2.48	3.66	1.68	1.18	1.65	1.53	2.23	2.04	1.74
3.29	2.36	1.06	3.18	1.03	1.47	1.01	1.02	2.18
2.80	2.24	4.06	4.19	3.45	2.94	5.21	3.53	3.47
12.26	11.64	11.96	14.31	11.89	14.12	19.63	13.68	13.32
3.25	1.86	2.08	4.23	3.27	3.36	4.36	2.21	3.21
3.80	4.94	2.65	3.13	3.59	6.27	12.52	1.01	3.63
1.91	2.91	2.10	3.42	0.63	4.22	3.57	5.44	2.97
8.96	9.71	6.83	10.78	7.49	13.85	20.45	8.66	9.81
3.53	1.63	4.93	4.45	3.58	3.80	1.74	1.13	2.67
1.81	1.16	4.90	2.51	3.00	5.04	2.74	5.22	2.90
3.70	1.86	1.96	7.54	4.07	3.14	2.15	2.63	2.88
9.04	4.65	11.79	14.50	10.65	11.98	6.63	8.98	8.45
30.26	26.00	30.58	39.59	30.03	39.95	46.71	31.32	31.58

rs. ‡ Not used in computing yearly means.

T

Precipitation at South Hartford, Washington Coun

(In

MONTH.	1863.	1864.	1865.	1866.	1867.	1868.	1
December	....	3.23	4.40	3.55	3.62	1.20	
January	....	1.56	2.60	1.18	1.41	4.00	
February	....	1.75	1.80	4.74	2.85	1.10	
March	....	2.95	6.08	1.94	1.95	2.45	
April	....	5.75	3.30	0.68	4.59	2.85	
May	....	6.53	7.53	1.06	8.50	6.20	
Total	....	21.77	25.71	13.15	22.92	17.80	
June	....	0.82	3.99	3.65	10.95	2.90	
July	....	1.95	4.56	2.46	3.73	0.80	
August	10.12	7.68	0.95	4.34	2.50	1.84	...
Total	....	10.45	9.50	10.45	17.18	5.54	...
September	2.80	4.55	2.08	5.28	1.30	....	
October	2.60	4.55	2.27	1.07	2.72	2.71	
November	2.13	6.90	4.96	4.96	3.00	8.30	
Total	7.53	16.00	9.31	11.31	7.02	... .	
Yearly total	....	48.23	44.52	34.91	47.12	....	...

*From record

E No. 7.

V. Y., *for the years indicated, from* 1863 *to* 1879.*

.)

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	Mean.
	4.15	1.72	3.72	3.86	....	....	1.90	3.18	0.25	5.15	3.12
	2.87	2.52	1.03	3.42	....	....	2.53	2.90	5.05	3.00	2.68
	3.72	2.51	1.95	2.90	....	....	4.85	0.42	1.70	....	2.66
	3.58	3.38	2.33	3.05	....	....	4.91	2.95	1.70	....	3.26
	1.85	1.95	2.05	3.25	....	....	2.15	1.95	3.25	....	2.71
	0.65	2.10	4.65	1.80	....	....	2.75	2.17	2.50	....	3.73
	16.82	14.18	15.73	18.28	....	....	19.09	13.57	14.45	....	18.16
	3.35	3.05	6.40	0.95	....	....	4.30	4.85	3.30	....	4.12
	3.70	5.45	4.15	4.15	....	....	5.30	4.85	4.35	....	3.74
	1.45	9.10	7.15	3.15	....	4.90	1.85	3.40	6.30	....	4.62
	8.50	17.60	17.70	8.25	....	....	11.45	13.10	13.95	....	12.48
	2.15	2.00	1.60	3.20	....	3.35	5.70	0.55	0.77	....	2.74
	2.95	3.50	2.90	4.45	....	6.90	1.20	4.75	4.21	....	4.04
	1.12	2.15	3.40	4.52	....	4.65	0.80	4.95	3.61	....	3.86
	6.22	7.65	7.90	12.17	....	14.90	7.70	10.25	8.59	....	10.64
	31.54	39.43	41.33	38.70	....	....	38.24	36.92	36.99	....	41.28

G. M. Ingalsbee.

1827 to 1848, *inclusive*.*

	1842.	1843.	1844.	1845.	1846.	1847.	1848.	Mean.
December	[illegible]	1.37	1.05	1.01	0.90	0.59	3.01	2.14
January	[illegible]	1.16	2.70	2.95	1.05	1.96	1.38	2.85
February	[illegible]	1.09	1.06	1.73	1.86	3.35	0.80	2.43
March	[illegible]	0.70	1.88	1.94	1.25	1.96	0.68	1.78
April	[illegible]	1.43	1.26	1.71	0.99	3.76	0.68	1.91
May	[illegible]	1.31	3.58	3.56	3.71	1.41	4.83	2.79
Total	[illegible]	7.06	11.53	12.90	9.76	13.03	11.38	13.40
June	[illegible]	4.09	4.10	1.07	2.34	3.48	1.14	3.42
July	[illegible]	5.13	1.77	4.25	2.53	1.22	8.29	3.67
August	[illegible]	2.90	1.77	2.98	0.91	2.36	2.45	2.85
Total	[illegible]	12.12	7.64	8.30	5.78	7.06	11.88	9.94
September	[illegible]	1.40	1.34	2.93	2.16	5.36	0.88	2.84
October	2.40	3.67	4.48	2.95	5.20	3.99	3.22	3.29
November	3.18	3.23	1.52	3.72	4.27	4.30	3.06	2.94
Total	[illegible]	8.30	7.34	9.60	11.63	13.65	7.16	9.07
Yearly total	[illegible]	27.48	26.51	30.80	27.17	33.74	30.42	32.41

m 1825 *to* 1849, *inclusive.**

	1843.	1844.	1845.	1846.	1847.	1848.	1849.	Means.
Decembe	4.05	2.13	2.12	‡(5.97)	†2.75	6.42	9.91	2.78
January	2.68	2.91	4.11	....	3.60	2.41	3.09	2.69
February	0.96	3.15	3.89	....	3.89	1.21	1.86	2.06
March ..	2.57	2.43	2.43	....	3.04	4.24	1.85	2.36
April ...	2.68	1.70	3,28	....	2.15	2.78	2.62	2.53
May	1.07	7.39	3.54	....	2.64	3.00	2.80	3.04
Total	14.01	19.71	19.37	....	18.07	20.06	22.13	15.46
June....	4.48	2.99	4.30	....	4.87	2.20	3.73	4.29
July	4.41	4.47	2.19	....	2.84	6.40	0.92	4.21
August..	3.81	4.04	0.94	....	2.55	2.71	3.95	3.66
Tota	12.70	11.50	7.43	....	10.26	11.31	8.60	12.16
Septemb	2.06	2.57	3.94	....	3.76	2.66	1.83	3.08
October	4.47	3.78	2.31	....	4.53	2.59	8.25	3.56
Novemb	4.59	2.00	3.84	....	2.26	0.40	4.22	2.46
Tota	11.12	8.35	10.09	....	10.55	5.65	14.30	9.11
Yearly t	37.83	39.56	36.89	....	38.88	37.02	45.03	36.73

TAB[illegible]

Precipitation at Johnstown Academy, Johnstown, Fulton Co[illegible]

MONTH.	1828.	1829.	1830.	1831.	1832.	1833.	1834.
December	†2.93	0.64	‡2.20	†2.93	1.10	‡3.51	[illegible]
January	2.99	4.11	....	3.60	4.50	....	[illegible]
February	2.57	2.51	....	3.61	3.86	....	[illegible]
March	3.19	2.15	....	3.05	0.80	....	[illegible]
April	2.88	4.49	....	3.25	0.97	....	[illegible]
May	4.82	2.63	....	2.23	4.79	....	[illegible]
Total	19.38	16.53	....	18.67	16.02	....	[illegible]
June	4.39	3.84	....	5.07	1.84	....	[illegible]
July	5.18	3.63	....	5.11	4.85	....	[illegible]
August	2.95	1.61	....	2.59	1.94	....	[illegible]
Total	12.52	9.08	....	12.77	8.63	....	[illegible]
September	4.12	3.49	....	2.70	1.05	....	[illegible]
October	2.00	3.10	....	3.82	1.29	....	[illegible]
November	4.66	2.83	....	0.75	3.33	....	[illegible]
Total	10.78	9.42	....	7.27	5.67	....	[illegible]
Yearly total	42.68	35.03	....	38.71	30.32	....	[illegible]

* From State metereorology. † Mean of [illegible]

10.

. *Y., for the years indicated, from* 1828 *to* 1845, *inclusive.**

	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.
1	0.50	6.90	4.95	‡3.45	....	†2.93	5.18	2.79	2.25	2.27	2.91
3	1.90	4.64	4.88	....	....	3.51	1.72	1.16	3.95	3.45	3.30
3	2.80	3.74	3.60	....	....	0.87	3.71	1.25	3.90	4.00	2.86
2	3.24	6.73	5.47	....	....	3.90	3.49	3.38	6.00	3.44	3.63
2	2.87	4.01	2.02	....	....	2.34	3.13	2.35	1.97	2.90	2.93
5	1.99	8.56	4.53	....	....	2.89	1.91	1.95	4.03	2.29	3.45
4	13.30	34.58	25.45	....	....	16.44	19.14	12.88	22.10	18.35	19.08
4	3.84	2.76	5.45	....	....	3.65	6.29	3.44	3.72	2.98	4.20
1	3.75	3.98	2.26	....	....	3.18	5.23	2.12	4.52	3.70	4.01
5	1.50	2.40	7.48	....	....	2.77	4.39	3.17	4.66	1.07	3.14
0	9.09	9.14	15.19	....	....	9.60	15.91	8.73	12.90	7.75	11.35
1	2.74	2.44	1.61	....	....	4.48	4.10	2.96	4.16	1.83	2.87
4	3.84	3.45	3.20	....	....	1.14	2.95	4.74	5.82	3.64	3.29
6	2.03	2.81	5.68	....	....	3.32	4.26	2.39	4.77	4.68	3.33
3	8.61	8.70	10.49	....	....	8.94	11.31	10.09	14.75	10.15	9.49
2	31.00	52.42	51.13	... .	....	34.98	46.36	31.70	49.75	36.25	39.92

years. ‡ Not used in computing totals.

The Absorption of Moisture by Soils.

Moreover different soils have different capacities for absorption of moisture. As illustrating this statement, we may refer to the experiments of Professor Schübler,* who determined the amount of moisture which various dry soils will absorb from the atmosphere. According to his experiments, 1,000 grains of earth spread out on a surface of fifty square inches, in a temperature which varied between 59° and 65.7° F. absorbed the following amounts of moisture in grains in the stated times:

	12 hours.	24 hours.	48 hours.	72 hours.
Siliceous sand	0	0	0	0
Calcareous sand	2	3	3	3
Gypsum powder	1	1	1	1
Sandy clay	21	26	28	28
Loamy clay	25	30	34	35
Stiff clay	30	36	40	41
Grey pure clay	37	42	48	49
Fine lime	26	31	35	35
Fine magnesia	69	76	80	82
Humus	80	97	110	120
Garden mould	35	45	50	52
Arable soil	16	22	23	23
Slaty marl	24	29	32	33

From the foregoing tabulation it is determined that soils possess different capacities for absorbing moisture from the air. Sand possesses this property in the smallest degree, while humus possesses it in the greatest degree. Ordinary arable soils and clays, garden mould, etc., possess it in a considerable degree. In any case the showing of this tabulation is such as to lead to the conclusion that not only the general character of the soil of a drainage basin, but of the weather as well, may influence the runoff of a

*Paper on the Physical Properties of Soil, and on the means of investigating them. By Professor Schübler, of the University of Tübingen. Jour. Royal Agric. Soc. of England, vol. I. pp. 177-218.

stream somewhat. By way of enforcing this statement we may refer to the views of Mr. O'Meara, as given in his paper on Irrigation in Colorado.* In this paper Mr. O'Meara discusses the loss of rainfall by evaporation in Colorado, taking the same view thereof that has been expressed in the Genesee storage report, page 662, Mr. O'Meara states that in Colorado westerly winds frequently carry away heavy snowfalls in the course of a few hours, almost without moistening the soil. We have there the case of a large loss of water by evaporation from a drainage area due to wind action, as well as an illustration, probably, of the tendency of certain soils to absorb moisture very slightly, as indicated by Schübler's table.

The Experiments of Baldwin Latham.

As another illustration of how greatly the amount of water evaporated from the surface of the ground will vary under the influence of vegetation, we may refer to statements made by Baldwin Latham, M. Inst. C. E., in discussing Mr. O'Meara's paper. Mr. Latham said that, beginning in June, 1870, he discharged sewage upon a definite area, planted with rye grass, at the Beddington-Croyden sewage farm, the grass being so placed in a water-tight tank six inches deep and provided with suitable underdrains and means of collecting any water that flowed off, that definite results could be obtained. The experiment was continued from June 18, 1870, to June 12, 1871, a period of 360 days, during which time 20.03 inches of rain fell, and the water evaporated from a square yard of surface amounted to 8,712 pounds, or to a depth of 186.3 inches in a year. The severe cold of the winter of 1870-1871 killed the grass, so that in January and February it was entirely without life. The effect of killing the grass was shown by decrease in evaporation. In December, when the grass was living, 193 pounds of water was evaporated, but in January, only 30 pounds, and in February, 82 pounds. Experiments on another plat, during the year 1871-72, gave for a period of 370 days, with a rainfall of 24.98

*Paper on the Introduction of Irrigation in New Countries as Illustrated in Northern Colorado. By Patrick O'Meara, M. Inst. C. E. Proc. Inst. C. E. vol. LXXIII (1883), p. 185.

udson river, from 1891 *to* 1896, *inclusive.*

shed.)

M	Evaporation.	1895. Mean temperature.	1895. Precipitation.	1895. Runoff.	1895. Evaporation.	1896. Mean temperature.	1896. Precipitation.	1896. Runoff.	1896. Evaporation.
December	....	23°.7	3.01	1.12	....	26°.0	4.18	2.79	....
January	....	16°.5	2.96	0.99	....	14°.7	2.25	1.74	....
February	....	12°.8	1.58	0.82	....	17°.9	6.36	1.12	....
March	....	21°.9	2.14	1.08	....	19°.9	5.56	3.49	....
April	....	41°.0	3.11	5.91	....	43°.8	1.19	6.20	....
May	....	56°.9	2.99	1.76	....	58°.1	2.63	1.18	....
Mean and tot	8.19	28°.8	15.79	11.68	4.11	30°.0	22.17	16.52	5.65
June	....	66°.8	2.61	0.70	....	61°.6	2.87	1.18	....
July	....	63°.8	3.13	0.66	....	67°.7	4.80	0.72	....
August	....	64°.0	4.63	1.00	....	65°.8	2.58	0.63	....
Mean and tot	5.53	64°.9	10.37	2.36	8.01	65°.0	10.25	2.53	7.72
September	....	58°.5	3.42	0.65	....	55°.8	4.93	0.71	....
October	....	40°.2	2.14	0.69	....	42°.7	2.85	1.05	....
November	....	35°.3	4.95	2.08	....	37°.5	5.01	2.82	....
Mean and tot	8.88	44°.7	10.51	3.42	7.09	45°.3	12.79	4.58	8.21
Yearly mean and	22.60	41°.8	36.67	17.46	19.21	42°.6	45.21	23.63	21.58

inches, a total application of water of 4,263 pounds per square yard, amounting to a depth of 91.2 inches over the area. These experiments indicate the large quantities of water which may be evaporated by growing crops, especially grass crops, provided a full supply of water is furnished.

Evaporation from Long and Short Grass.

Observations as to the evaporation from meadow and grass crops generally, in conjunction with evaporation from water surfaces, have been made at various places, as, for instance, Emdrup and Copenhagen, in Denmark.* According to these observations it appears that the mean evaporation from water for a period of eleven years in Denmark was 27.9 inches. The mean evaporation from short grass for a period of eight years was determined at 30.1 inches, while for long grass, for a period of eight years, the mean evaporation is given at 44 inches. Inasmuch as these interesting tables may be readily referred to at the place cited, they are not reproduced here. As regards the general question of evaporation, Mr. Beardmore states that the amount from land must generally be below the actual rainfall, but will vary at different places according to the character of the soil, the vegetation, the contour of the district and the character of the rainfall during any particular season. Immediately after rain, evaporation proceeds rapidly, especially from light soil with scant vegetation and surface exposed to the full action of the sun and wind; the result is that the surface soon becomes dessicated and the amount of evaporation then decreases. In a well wooded district, evaporation from the surface of the ground is less active than in an open country, although the process is more constant than from open, exposed soil; it is especially active in the spring and early summer months, while the development of foliage is taking place.†

Evaporation in England.

In order to show the relation between rainfall, evaporation and temperature, we may refer to the following, also taken from Beard-

*See A Manual of Hydrology. By Nathanial Beardmore, pp. 296c-296d.
†Beardmore's Manual of Hydrology, p. 296.

more. At Little Bridy, Dorset, England, the following results were obtained from an evaporating dish, the surface of which was four inches above the ground and 448 feet above the level of the sea. The rainfall and evaporation are given in inches:

Year.	Annual rainfall.	Annual evaporation.	Mean annual temperature.
1858..............	36.41	25.86	48.4°
1859..............	38.98	29.04	50.1°
1860..............	48.93	22.85	54.6°

At Radcliffe Observatory, Oxford, England, we have the following, the evaporation being calculated from observations of dry and wet bulb thermometers. Rainfall and evaporation are given in inches as before:

Year.	Annual rainfall.	Annual evaporation.	Mean annual temperature.
1852..............	40.4	34.79	50.0°
1853..............	26.2	31.84	47.5°
1854..............	70.7	36.2	49.2°
1855..............	25.2	27.6	47.2°
1856..............	26.9	24.55	48.7°

Evaporation at Demerara.

For results in a tropical region we have the following from the Georgetown Observatory, Demerara, the height above sea level being ten feet. Rainfall and evaporation in inches:

Year.	Annual rainfall.	Annual evaporation.	Mean annual temperature.
1854..............	95.16	33.74	79.1°
1855..............	87.36	33.71	80.6°
1856..............	87.74	37.91	79.1°

	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	Mean.
Dec	29.84	23.67	27.90	34.18	35.63	28.91	24.86	23.23	35.17	28.67	23.80	31.40	28.29
Jan	26.65	26.13	26.50	29.92	20.83	27.65	25.58	19.25	25.16	26.92	30.57	* 22.15	24.48
Feb	24.73	20.87	24.91	25.63	20.82	28.97	30.85	27.48	28.03	24.20	22.57	† 22.18	25.07
Ma	39.46	37.51	30.35	33.47	36.90	33.39	37.51	32.15	36.55	34.18	34.60	27.46	34.72
Apr	47.36	52.40	44.28	48.88	44.12	43.48	46.37	41.79	46.84	44.41	47.20	48.21	47.33
Ma	59.21	63.30	61.47	63.06	57.10	53.08	57.19	58.65	59.44	61.98	60.98	55.16	59.60
	37.79	37.14	35.90	39.18	35.90	35.91	36.97	33.76	38.53	36.72	36.61	34.43	36.58
Jun	69.51	68.22	66.82	69.94	67.63	67.92	64.35	67.54	70.49	69.99	66.70	‡ 70.33	68.14
Jul	73.83	72.94	74.53	71.62	72.20	72.62	70.33	72.40	71.30	77.33	75.11	75.54	72.53
Au	74.08	72.53	71.08	71.92	69.91	68.06	67.26	67.92	71.55	71.33	69 51	‖ 66.56	69.88
	72.37	71.22	70.79	71.16	69.91	69.53	67.31	69.29	71.11	72.88	70.44	70.81	70.18
Sep	61.08	68.30	61.92	58.78	59.78	60.57	62.20	60.56	62.59	64.06	65.10	‡ 62.61	61.64
Oc	53.28	49.87	49.50	50.90	49.18	49.79	53.15	51.33	47.78	53.59	52.10	‡ 49.60	49.83
No	43.27	44.73	44.12	38.81	46.18	42.15	36.02	39.10	40.85	41.53	43.05	‡ 39.77	39.43
	52.53	54.30	51.85	49.33	51.71	51.84	50.46	50.33	50.41	53.06	53.42	50.66	50.30
Ye	50.15	49.96	48.61	49.72	48.36	48.05	47.93	46.78	49.65	49.93	49.27	47.58	48.41

r. § No record. Mean of 30 years used.

TABLE

Mean Temperature at Alban

MONTH.	1879.	1880.	1881.	1882.	1883.	1884.
December	28	29	25	39	31	31
January	18	31	20	27	23	24
February	19	28	27	33	29	33
March	30	33	37	39	30	36
April	42	50	47	47	47	46
May	61	66	65	56	59	59
Mean	33.0	39.5	36.8	40.0	36.5	38.5
June	66	72	65	69	72	72
July	71	75	74	74	73	71
August	68	71	73	73	70	73
Mean	68.3	72.6	70.7	72.0	71.7	72.0
September	60	65	71	65	61	68
October	56	51	55	56	51	51
November	37	38	44	41	44	38
Mean	51.0	51.3	56.7	54.0	52.0	52.3
Yearly mean	46.3	50.8	50.2	51.6	49.2	50.3

* From record

). 12 A.

*rom 1879 to 1895, inclusive.**

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Mean.
30	24	28	30	35	20	37	26	26	29	29.2
20	21	15	30	31	25	24	17	27	23	23.4
23	25	23	20	31	28	26	22	21	19	25.0
33	28	26	35	31	32	30	31	40	30	32.0
50	48	44	48	47	49	46	44	48	47	46.6
59	65	58	61	57	57	57	58	60	62	59.8
35.8	34.3	32.3	37.3	38.7	35.2	36.7	33.0	37.0	35.0	36.0
66	69	69	67	68	68	71	70	70	73	69.0
72	77	70	72	71	69	73	72	75	70	72.5
70	68	70	70	71	71	72	72	69	72	70.6
69.3	71.3	69.7	69.7	70.0	69.3	72.0	71.3	71.3	71.7	70.7
63	59	63	64	62	67	62	59	67	67	63.7
52	49	44	49	51	50	51	54	58	47	51.2
40	38	40	43	38	39	38	39	36	41	39.7
51.7	48.7	49.0	52.0	50.3	52.0	50.3	50.7	52.0	51.7	51.5
48.2	47.2	45.9	49.1	49.4	47.9	48.9	47.0	49.3	48.3	48.5

Weather Bureau.

TABI

Mean temperature at Glens I

MONTH.	1879.	1880.	1881.	1882.	1883.	1884.
December	26.5	26.1	17.3	33.2	23.8	23.9
January	14.7	28.9	10.8	21.4	16.9	12.9
February	17.5	26.9	21.0	26.5	23.9	26.0
March	29.3	30.0	33.8	34.0	25.7	30.6
April	44.6	50.1	45.1	42.9	44.3	46.4
May	66.3	68.5	63.1	54.8	58.0	58.5
Mean	33.2	38.4	31.8	35.4	32.1	33.0
June	69.5	72.3	63.8	67.0	71.4	71.5
July	73.7	75.2	72.7	74.2	71.1	70.3
August	70.7	71.5	73.2	74.2	70.0	71.8
Mean	71.3	73.0	69.9	71.8	70.8	71.2
September	62.1	66.5	69.5	64.6	60.7	66.4
October	58.4	51.4	50.2	54.2	48.6	51.0
November	37.3	34.3	38.0	36.4	39.3	37.2
Mean	52.6	50.7	52.6	51.7	49.5	51.5
Yearly mean	47.8	50.1	46.5	48.6	46.1	47.2

* From record

No. 13.

's, from 1879 *to* 1895, *inclusive.**

.)

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Mean.
26.6	19.5	25.0	28.0	32.2	16.9	34.8	24.4	22.6	26.9	25.5
18.3	16.6	9.6	28.1	26.9	22.7	21.6	13.0	24.3	20.8	19.2
18.8	22.1	20.0	18.7	27.8	26.6	25.0	20.1	19.3	17.7	21.6
31.8	25.7	26.6	35.9	30.3	32.4	29.6	30.7	39.4	29.2	30.4
51.7	41.6	43.2	51.4	48.5	50.2	48.3	44.2	50.0	48.2	46.8
58.7	66.4	58.6	63.4	58.5	58.5	57.3	60.2	61.5	68.6	60.9
34.3	32.0	30.5	37.6	37.4	34.5	36.1	32.1	36.2	34.4	34.1
66.7	69.6	69.7	68.6	69.3	66.6	70.9	71.4	70.1	73.2	69.4
72.2	74.8	72.6	73.0	70.0	69.8	73.3	71.4	74.6	71.1	72.5
69.8	68.7	71.1	69.6	68.2	71.1	71.0	71.1	68.9	70.7	70.5
69.6	71.0	71.1	70.4	69.2	69.2	71.7	71.3	71.2	71.7	70.8
64.9	58.9	60.0	62.9	61.2	66.3	62.3	57.1	66.2	65.2	63.1
51.6	48.7	44.2	46.1	49.8	49.8	50.3	54.1	52.7	47.1	50.5
37.7	36.3	38.7	40.9	36.5	38.2	37.7	38.2	35.0	39.2	37.7
51.4	48.0	47.6	50.0	49.2	51.4	50.1	49.8	51.3	50.5	50.4
47.4	45.7	44.9	48.9	48.3	47.4	48.5	46.3	48.7	47.7	47.4

t by J. Lapham.

TABL

Mean temperature at Keene Valley, Essex C

MONTH.	1879.	1880.	1881.	1882.	1883.	1884.
December	†23.5	24.7	15.7	31.7	20.0	20.1
January	20.5	29.7	10.5	18.4	12.3	12.5
February	18.8	23.2	14.7	25.1	19.0	23.3
March	28.4	25.6	28.3	28.4	19.4	26.9
April	37.8	39.7	36.1	36.3	35.5	33.5
May	56.5	56.8	57.0	41.8	48.1	49.7
Mean	30.9	33.3	27.0	30.3	25.7	28.5
June	61.4	60.8	54.8	58.8	68.8	61.2
July	65.0	62.8	64.1	63.8	63.3	60.7
August	62.2	60.6	63.6	62.8	60.7	62.5
Mean	62.9	61.4	60.8	61.8	62.6	61.4
September	54.4	55.9	62.5	54.9	52.7	57.2
October	54.8	42.3	44.8	47.2	41.7	43.0
November	33.4	27.2	34.8	29.0	34.8	31.5
Mean	47.5	41.8	47.4	43.7	43.1	43.9
Yearly mean	43.0	42.5	40.5	41.5	39.3	40.6

* Record kept by O. S. Phelps. † These two months missing from

No. 14.

nty, N. Y., from 1879 *to* 1895, *inclusive.**

)

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Mean.
23.6	18.1	21.7	25.2	28.9	13.8	34.9	23.6	22.8	27.9	23.5
18.3	15.9	11.0	26.0	24.7	22.1	22.1	14.1	27.1	22.3	19.1
19.6	19.2	20.5	17.7	26.6	26.5	24.6	21.4	19.1	20.7	20.6
27.6	25.3	25.4	29.7	29.2	30.1	26.7	30.4	39.3	28.5	27.4
43.8	38.1	38.0	43.3	42.0	46.7	43.1	40.6	45.4	43.3	40.4
54.7	59.4	53.2	58.7	52.9	54.4	54.2	55.9	59.2	60,7	54.4
31.3	29.3	28.3	33.4	34.0	32.3	34.3	31.0	35.5	33.9	30.9
61.7	64.7	65.0	64.6	65.3	65.7	68.5	‡63.4	69.2	68.3	63.4
66.8	71.2	64.5	68.5	67.6	66.5	68.3	67.2	70.7	67.3	66.1
61.4	61.2	64.6	63.7	64.8	68.2	67.1	66.9	64.2	66.7	63.7
63 3	65.7	64.7	65.6	65.9	66.8	68.0	65.8	68.0	67.4	64.4
55.4	53.6	54.6	58.6	57.0	64.7	58.8	55.1	63.7	61.0	57.3
46.5	43.2	37.2	39.3	45.8	46.2	47.2	51.5	50.1	44.0	45.2
33.9	33.0	34.6	36.7	33.4	36.4	37.8	37.2	33.1	39.0	34.0
45.3	43.3	42.1	44.9	45.4	49.1	47.9	47.9	48.8	48.0	45.5
42.8	41.9	40.9	44.3	44.8	45.1	46.1	43.9	46.9	45.8	42.9

al record; the mean has been used. ‡ Missing from original record.

TABLE

Mean Temperature at Cambridge Washington Academy, Camb

MONTH.	1827.	1828.	1829.	1830.	1831.
December	† 26.03	29.75	33.80	36.53	33.06
January	14.41	29.36	22.08	23.73	20.56
February	24.66	33.36	17.57	18.79	19.74
March	34.46	36.75	30.05	34.52	38.82
April	48.33	41.71	45.38	49.69	46.82
May	55.99	59.16	59.47	54.19	61.09
Mean	33.98	38.35	34.72	36.24	36.68
June	64.46	70.10	65.66	59.57	67.83
July	69.46	68.96	67.73	70.73	71.62
August	66.02	68.03	66.23	67.57	70.70
Mean	66.65	69.03	66.54	65.96	70.05
September	56.00	57.49	54.29	63.40	61.54
October	44.80	45.48	48.19	52.30	49.34
November	32.82	40.29	37.50	47.63	38.35
Mean	44.54	47.75	46.66	54.44	49.74
Yearly mean	44.79	48.37	45.66	48.22	48.29

* From State meteorology. † Mean of thir

ɔ. 15.

e, Washington County, N. Y., from 1827 *to* 1841, *inclusive.**

1833.	1834.	1835.	1836.	1837.	1838.	1839.	1840.	1841.	Mean.
28.30	26.29	22.67	17.78	24.57	24.96	19.96	(‡ 25.09)	† 26.03	26.10
28.05	20.81	19.49	21.92	12.25	30.06	21.12	....	26.80	22.44
18.49	32.56	19.01	13.68	21.21	13.11	25.18	....	19.49	21.45
28.76	34.83	30.47	26.03	29.42	34.74	35.25	....	30.33	32.69
47.84	47.14	42.01	40.38	41.33	38.40	46.59	....	41.63	44.19
59.15	55.49	55.67	56.84	53.41	53.67	54.21	....	53.39	55.99
35.10	36.27	31.55	29.43	30.36	32.49	33.72	....	32.94	33.81
60.37	63.75	65.16	65.11	64.23	67.73	59.49	....	69.37	64.82
66.58	72.70	68.42	69.60	64.61	70.29	68.27	....	67.42	68.88
64.75	66.10	63.83	60.97	63.99	66.21	65.17	....	68.69	66.09
63.90	67.52	65.80	65.23	64.28	68.08	64.31	....	68.49	66.60
59.22	59.38	53.59	58.44	56.48	59.19	56.94	....	61.43	58.29
46.49	44.89	50.81	39.77	44.02	45.17	46.94	....	48.08	46.76
34.14	34.12	36.65	34.86	36.43	32.04	33.14	....	35.24	36 56
46.62	46.13	47.01	44.86	45.64	45.47	45.67	....	48.23	47.20
45.18	46.55	43.98	42.11	42.66	44.63	44.35	....	45.65	45.35

ι. ‡ Not used in computing yearly means.

TABLE

Mean temperature at Granville Academy, Granville, Washington [illegible]

MONTH.	1835.	1836.	1837.	1838.	1839.	18[illegible]
December	†24.70	17.39	‡25.10	24.70	19.39	[illegible]
January	19.80	22.26	....	24.99	20.01	[illegible]
February	20.94	18.74	....	12.37	24.64	[illegible]
March	30.53	29.17	....	32.63	31.96	[illegible]
April	41.76	42.04	....	37.46	46.22	[illegible]
May	55.56	60.08	....	53.20	52.59	[illegible]
Mean	32.21	30.78	....	30.89	32.42	[illegible]
June	64.87	71.93	....	69.73	60.94	[illegible]
July	69.67	75.28	....	74.67	67.41	[illegible]
August	66.87	65.24	....	69.99	63.84	[illegible]
Mean	66.95	70.82	....	71.46	64.06	[illegible]
September	51.79	60.50	....	62.63	57.85	[illegible]
October	51.01	48.09	....	44.90	49.29	[illegible]
November	35.47	37.22	....	27.67	33.57	[illegible]
Mean	46.09	48.60	....	45.07	46.90	[illegible]
Yearly mean	44.37	45.24	....	44.58	43.95	[illegible]

* From State meteorology. † Mean of thirteen [illegible]

[o. 16.

nty, N. Y., for the years indicated, from 1835 *to* 1849, *inclusive.**

1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	Mean.
23.92	30.36	22.11	27.35	24.36	20.73	23.88	29.29	30.30	24.68
26.44	23.39	27.34	9.81	21.81	19.66	21.89	25.12	15.12	20.67
21.22	28.76	14.67	18.98	22.97	14.81	19.61	22.12	16.53	20.09
34.56	36.03	21.83	29.59	33.72	32.90	26.54	30.00	33.99	31.29
42.43	44.93	43.25	48.52	42.81	48.28	39.18	43.70	41.58	43.63
57.79	53.08	54.03	56.81	52.34	60.13	58.46	61.21	54.44	56.15
34.39	36.09	30.54	31.84	33.00	32.75	31.59	35.24	31.98	32.75
73.71	63.08	63.79	63.80	64.15	66.51	65.45	67.49	68.41	66.49
73.28	68.05	67.49	67.41	67.42	72.33	72.84	70.50	72.00	70.82
70.31	68.14	69.40	66.84	69.27	71.27	68.46	68.62	69.97	68.28
72.43	66.42	66.89	66.02	66.95	70.04	68.92	68.87	70.13	68.53
63.89	55.62	58.91	58.22	56.40	63.66	60.01	57.04	56.96	58.72
48.55	58.40	42.32	45.47	48.97	45.72	45.20	47.33	46.68	47.70
34.55	33.53	32.99	33.39	39.25	41.25	39.86	34.56	43.47	35.88
48.99	49.18	44.74	45.69	48.21	50.21	48.36	46.31	49.04	47.43
47.55	46.95	43.18	43.85	45.29	46.44	45.11	46.41	45.78	45.37

rs. ‡ Not used in computing yearly averages.

TAB

Mean Temperature at South Hartford, Washington Co

MONTH.	1863.	1864.	1865.	1866.	1867.	1868
December	....	25.2	27.4	29.2	25.0	19.7
January	....	24.2	16.8	18.6	14.2	16.3
February	....	29.0	22.9	25.0	30.5	15.4
March	....	34.5	33.6	31.4	31.1	34.5
April	....	45.6	50.4	53.5	47.0	41.8
May	....	64.1	58.4	59.3	56.2	57.7
Mean	....	37.1	35.7	36.2	34.0	30.9
June	....	70.0	72.5	68.0	71.2	70.0
July	....	75.1	72.2	75.9	72.2	79.0
August	71.6	73.6	72.0	66.1	73.0	72.1
Mean	....	72.9	72.2	70.0	72.1	73.7
September	59.7	60.8	68.2	62.1	60.1	63.4
October	53.7	49.0	46.2	52.0	53.6	46.0
November	41.2	39.1	39.1	41.7	38.5	36.2
Mean	51.5	49.6	51.2	51.9	49.7	48.5
Yearly mean	....	49.2	48.7	48.6	47.5	46.0

*From record kept by G. M.

No. 17.

, New York, for the years indicated, from 1863 *to* 1879.*

.)

1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	Mean.
27.6	28.2	22.7	18.4	....	....	25.9	18.3	32.8	28.9	25.1
29.7	20.8	22.4	18.8	....	....	29.1	15.1	22.5	17.5	20.8
22.4	24.4	20.3	20.8	....	....	24.2	30.0	24.2	... ...	24.2
28.9	40.5	22.1	28.6	....	....	29.8	32.4	37.8	....	31.9
49.9	48.5	44.8	44.1	....	... .	44.6	48.6	52.4	....	47.5
60.6	59.7	60.6	59.1	....	....	57.6	59.1	60.4	....	59.3
36.5	36.9	32.2	31.6	.... ..	....	35.2	33.9	38.3	....	34.8
75.5	68.8	69.6	68.9	....	....	74.7	71.2	67.3	....	70.4
77.4	72.3	76.0	73.8	....	....	77.9	76.6	77.0	....	75.2
75.2	72.5	74.7	68.6	....	72.7	75.9	74.0	73.2	....	72.5
76.0	71.2	73.4	70.4	....	....	76.2	73.9	72.5	. ....	72.7
66.5	58.6	65.2	63.2	....	60.1	60.3	67.3	66.7	....	63.3
53.7	52.1	49.6	50.8	....	48.4	48.2	51.7	56.0	....	50.6
40.4	32.8	37.8	29.3	....	31.0	40.7	41.6	39.2	....	37.6
53.5	47.8	50.9	47.8	....	46.5	49.7	53.5	54.0	....	50.5
50.6	48.2	47.2	45.4	....	....	49.1	48.8	50.7	....	48.2

alsbee, Smithsonian Observer.

Evaporation at Bombay.

From Bombay, India, we obtain the following results. Rainfall and evaporation in inches:

Year.	Annual rainfall.	Annual evaporation.	Mean annual temperature.
1849..............	114.89	71.99	80.1°
1850..............	50.24	79.87	80.4°
1851..............	96.07	78.13	80.1°
1852..............	69.27	86.07	81.3°
1853..............	62.55	95.33	81.1°

Evaporation at Boston.

According to Mr. FitzGerald, the mean evaporation from water surface at Chestnut Hill reservoir, Boston, as determined from sixteen years' observation, is 39.20 inches.* The rainfalls in the vicinity of Boston, so far as they are available, are given in tables 21-23, inclusive.

Evaporation at Rochester.

Tables Nos. 6 and 7, of the Genesee storage report, for 1896, may be referred to as giving evaporation data at Rochester, New York, for the years from 1891 to 1896, inclusive. Mean temperature for Rochester for the same years may be obtained from Table No. 24 of the Genesee storage report.

Without attempting to analyze all this data at this time it may be simply pointed out as sufficient for present purposes that there is apparently a moderate increase in evaporation for an increase in mean temperature and rainfall. As to which of these elements is the more important can not well be determined at this time. More extended data are needed before drawing final conclusions. As covering information as to evaporation in forests, Table No. 7 A of the Genesee storage report may be referred to.

*For tabulation giving the evaporation from a water surface, in inches, by months and years, see Table No. 5 of Mr. FitzGerald's paper on Rainfall, Flow of Streams and Storage. Trans. Am. Soc. C. E., Vol. XXVII. (Sept. 1892), p. 275.

THE RELATION OF RAINFALL TO RUNOFF.

The problem of the relation of rainfall to runoff has attracted the attention of meterologists for many years and records of stream flow have been kept in England and elsewhere as far back as fifty to seventy years ago, and the results tabulated with reference to solution of this problem. A few of these records, given by Beardmore may be referred to somewhat at length.*

TABLE No. 17 A.

Mean temperature at Gloversville, Fulton county, N. Y., from 1892 to 1896.

(F°.)

MONTH.	1892.	1893.	1894.	1895.	1896	Mean.
December	......	21.8	22.1	24.7	28.0	24.0
January	......	12.7	23.2	18.1	16.6	17.6
February	......	18.1	15.7	16.9	20.1	17.7
March	......	27.0	34.6	25.6	22.8	27.5
April	......	40.1	45.1	44.1	46.5	44.0
May	50.5	54.0	56.4	58.6	59.4	55.8
Mean	......	28.9	32.8	31.3	32.2	31.1
June	66.4	67.0	66.1	68.4	68.0	66.2
July	67.9	67.0	69.1	6[illegible].8	69.8	67.9
August	65.9	67.6	64.0	66.0	67.7	66.2
Mean	66.7	67.2	66.4	66.7	66.8	66.8
September	56.6	54.2	61.7	60.5	58.2	58.2
October	45.8	49.0	49.1	41.6	44.8	46.1
November	33.6	34.1	32.1	36.8	39.6	35.2
Mean	45.3	45.8	47.6	46.3	47.5	46.5
Yearly mean	......	42.7	44.9	43.9	44.7	43.9

The River Lea in England.

For the first we have the river Lea in England. The height of the district from whence this stream issues is from 80 to 500 feet above the sea; the drainage area, 444 square miles. In 1851, the total rainfall was 22.62 inches; the runoff 6.00 inches; the difference representing the evaporation loss, 16.62 inches. The mean temperature for 1851 was 49.2° F. In 1852, the rainfall was 39.71 inches; the runoff, 9.13 inches, and the evaporation 30.58 inches. The mean temperature for 1852 was 50.6°. For the year 1856, the rainfall was

*Beardmore's Manual of Hydrology, p. 154, and following.

†From reports of State Weather Bureau.

23.91 inches; the runoff 5.57 inches, and the evaporation 18.34 inches. The mean temperature for 1856 was 48.70°.

The data of the rivers Lea and Saone, given by Beardmore, are interesting, because they indicate that the importance of a statement of mean temperature, as a part of any study of the relation of rainfall to the runoff of streams, has been recognized for a long time

Loch Katrine, Scotland.

The Loch Katrine district, with precipitous slopes, elevated from 400 to 2,500 feet above the sea, and an area of 71.6 square miles, gave the following data for the year 1854: Rainfall 103.3 inches; runoff 81.7 inches; and evaporation, 21.6 inches.

The River Robe, Ireland.

The river Robe in the county of Mayo, Ireland, has a drainage area of 109.4 square miles; the height of the district drained above tide water varies from about 100 to 370 feet, with a mean height of about 180 feet. One-tenth of the drainage area is bog and low land, the remainder clay and sand, overlying porous, limestone rock. During the year 1851, the total rainfall was 45.60 inches, the runoff 28.3 inches; and the unaccounted balance, which may be considered as evaporation from the entire area, 17.57 inches. In 1852 the total rainfall was 53.09 inches; the runoff, 30.25 inches, giving an unaccounted for balance to be taken as evaporation of 22.74 inches.

Rivington Pike, England.

As another stream we may refer to Rivington Pike, Lancashire, with a drainage area of 16.25 square miles, and height above sea varying from 900 to 1.525 feet. In 1847 the rainfall was 50.18 inches, the runoff 38.75 inches, giving an evaporation of 11.43 inches. In 1848, the rainfall was 53.24 inches, the runoff, 41.10 inches, giving an unaccounted for balance as evaporation of 12.14 inches.

The River Tiber, Italy.

Records of the flow of the Tiber at Rome have been kept for the 28 years, from 1822 to 1849, inclusive. The drainage area above

Rome is mountainous but free from snows, glaciers or lakes; it comprises 6,450 square miles. Floods rise very rapidly, frequently from 30 to 45 feet above the summer level. For the twenty-eight year period, the average rainfall of Rome and Perugia is given at 31.06 inches. The average runoff for the period is 21.62 inches; the difference, representing the mean evaporation, is 9.44 inches.

The River Saone, France.

The river Saone was gaged near Lyons, France, during the years 1852-5, inclusive. Its drainage area is 11,551 square miles; the height of the headwaters above the sea varies from about 2,300 to 3,600 feet; height of the district of the main river, from 800 to 1,200 feet. The recorded rainfalls are the means of twelve stations. For the year 1852, the mean rainfall was 39.70 inches; the runoff, 22.10 inches; hence the evaporation was 17.60 inches. Evaporation from a water surface, as observed at Dijon for the same year was 24.42 inches, and the mean temperature 53.0°. For 1853, the mean rainfall was 34.0 inches, with a runoff of 20.4 inches; the evaporation being 13.6 inches. The observed evaporation from a water surface for 1853, was 18.42, and the mean temperature, 50.2°. For the year 1854, the rainfall was 28.0 inches; the runoff, 18.6 inches, giving an evaporation of 10.4 inches. The observed evaporation from a water surface was 18.34 inches, and the mean temperature was 51.3°.

Each Drainage Area a Law to Itself.

The great variability in runoff of streams indicated by the foregoing examples from England, Scotland, Ireland, Italy and France will serve to point out the complexity of the problem. Taking into account the diversity of the results, we may say in effect that every drainage area is largely a law unto itself.

PERCOLATION DATA.

As another class of information applying to the subject in hand we may refer to the data obtained from the drain gages at Rothamsted, Nash Mills, Lea Bridge and other places in England. Inasmuch as the data obtained from drain gages are of importance in a

TABLE [cut off]

Mean Temperature at Lowville Academy, Lowville, Lewis co. [cut off]

MONTH.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.
December	†28.46	24.89	28.51	32.34	27.70	11.80	24.29	‡(24.78
January	16.31	25.76	16.76	15.35	18.90	21.06	24.99	......
February	28.42	31.09	15.68	17.61	17.77	19.38	16.45	......
March	31.61	33.46	26.67	31.20	35.32	20.28	27.95	......
April	45.79	40.61	43.20	49.76	45.29	40.02	50.96	......
May	54.09	57.88	58.50	52.91	56.74	52.82	58.73	......
Mean	32.45	35.61	31.55	33.20	32.79	27.56	33.89	......
June	62.72	69.27	64.17	60.00	69.45	63.50	58.54	......
July	69.80	65.58	65.27	70.47	67.48	68.91	66.02	......
August	64.61	68.74	64.59	64.42	68.88	67.09	64.74	......
Mean	65.71	67.86	64.68	64.96	68.59	66.50	63.10	......
September	56.68	59.28	52.47	54.75	57.77	59.65	56.36	......
October	45.99	46.26	48.03	48.85	49.02	47.79	44.56	......
November	29.35	36.58	32.86	42.63	34.22	35.05	34.26	......
Mean	44.01	47.46	44.45	48.58	47.00	47.50	45.06	......
Yearly mean	43.65	46.64	43.06	44.98	45.29	42.28	43.99	......

* From State meteorology. † Mean of eight [cut off]

No. 18.

N. Y., for the years indicated, from 1827 *to* 1840, *inclusive.**

1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	Mean.
‡(16.19)	†23.46	‡(22.43)	†23.46	23.12	20.34	25.10	18.47	26.03	23.49	17.02	29.73	26.15	23.83
......	12.21	......	23.09	12.55	25.01	25.15	23.88	11.48	22.97	22.00	19.58	23.45	20.10
......	19.65	......	23.97	27.27	19.58	25.45	13.38	22.81	23.58	17.61	20.71	21.31	20.68
......	26.81	......	31.96	31.72	28.18	35.82	21.74	31.42	34.63	32.78	25.61	28.33	29.67
......	38.18	......	49.39	48.08	38.65	47.81	43.80	46.84	43.10	47.79	37.12	43.29	44.28
......	52.23	......	53.52	57.44	53.05	50.21	50.40	55.86	51.78	57.64	57.67	59.14	55.00
......	28.76	......	34.23	33.36	30.80	34.92	29.44	32.41	33.25	32.47	31.74	33.61	32.26
......	64.42	......	58.61	62.66	69.34	60.51	59.67	61.86	63.33	62.74	59.97	64.48	62.99
......	64.57	......	70.75	70.79	67.51	67.52	65.91	66.49	69.15	67.91	71.85	66.55	67.88
......	64.21	......	66.08	68.63	65.67	64.46	62.72	62.84	67.01	65.08	65.04	60.46	65.23
......	64.40	......	65.15	67.36	67.51	64.16	62.77	63.73	66.50	65.24	65.62	63.83	65.37
......	59.49	......	58.23	56.85	59.95	55.70	59.67	58.04	55.51	61.94	56.90	55.16	57.27
......	43.59	......	51.14	46.13	40.57	46.25	40.99	40.74	46.50	41.77	45.53	46.98	45.87
......	34.83	......	31.40	35.99	31.92	31.64	29.11	30.91	34.28	37.82	39.29	32.24	34.09
......	45.80	......	46.92	46.32	44.15	44.53	43.26	43.23	45.43	47.01	47.24	44.78	45.74
......	41.98	......	45.13	45.10	43.31	44.63	41.23	42.94	44.61	44.30	44.08	43.96	43.91

ars. ‡ Not used in computing yearly mean.

TABL

Mean temperature at Fairfield Academy, Fairfield, Herkimer C

MONTH.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.
December	†23.10	25.01	‡30.69	......	†23.10	13.35	21.97	‡26.01	†23.1?
January	16.82	24.09	......	......	13.52	21.65	21.89	......	22.25
February	22.67	32.80	......	......	20.38	21.59	17.78	......	15.07
March	29.09	33.12	......	......	37.72	32.99	29.61	......	25.18
April	46.57	39.03	......	......	46.31	41.66	46.68	......	38.79
May	53.07	53.11	......	......	55.54	54.17	58.71	......	55.55
Mean	31.89	34.53	......	......	32.76	30.90	32.77	......	29.99
June	61.35	72.96	......	......	67.05	63.44	57.92	......	64.58
July	66.20	69.75	......	......	67.21	65.27	60.93	......	62.84
August	64.75	69.68	......	......	66.49	65.58	59.16	......	63.81
Mean	64.10	70.80	......	......	66.92	64.76	59.34	......	63.74
September	57.84	58.77	......	......	59.16	62.05	61.76	......	60.24
October	46.62	44.51	......	......	55.56	47.91	57.46	......	58.65
November	28.16	35.69	......	......	31.02	40.33	50.85	......	32.57
Mean	44.21	46.32	......	......	48.58	50.10	56.69	......	50.49
Yearly mean	43.02	46.54	......	......	45 25	44.16	45.39	......	43.56

* From State meteorology. † Not in record.

o. 19.

, N. Y., for the years indicated, from 1827 *to* 1849, *inclusive.**

1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	Mean.
22.16	23.28	18.38	27.65	20.32	25.20	21.21	25.33	24.00	‡17.68	†23.10	28.42	28.71	22.83
14.90	27.70	17.17	11.89	23.46	22.27	27.22	10.95	21.94	......	20.25	23.78	14.57	19.86
20.49	10.63	23.50	26.67	20.46	26.57	14.04	21.76	21.66	......	19.96	19.45	15.84	20.44
26.39	38.57	30.35	30.78	27.05	34.34	20.24	30.51	32.98	......	24.30	27.12	31.12	29.58
38.63	34.51	47.68	45.84	37.64	43.54	40.87	46.22	40.93	......	37.66	40.12	38.22	41.72
46.76	49.25	51.84	55.79	50.27	52.22	53.50	54.30	50.88	......	54.73	56.62	49.12	53.53
28.22	29.82	31.48	33.10	29.87	34.02	29.51	31.51	32.06	......	30.00	32.58	29.60	31.33
62.02	62.64	57.30	60.43	65.61	60.60	61.00	61.34	62.31	......	60.10	61.58	63.94	62.54
62.68	66.05	70 61	66.86	64.22	68.20	65.89	64.38	65.35	......	68.70	64.47	68.11	66.07
60.15	61.69	76.48	66.15	66.85	68.26	67.32	62.97	67.88	......	65.39	66.68	66.68	65.64
61.62	63.46	68.13	64.48	65.56	65.69	64.74	62.90	65.18	......	64.73	64.23	66.24	64.75
58.17	57.31	58.14	54.56	60.58	55.40	57.98	57.14	55.26	...	55.84	51.46	57.11	57.82
43.23	38.91	49.74	44.47	40.23	44.61	40.90	42.72	47.84	......	42.85	44.31	44.85	45.94
34.24	29.70	31.02	34.30	31.28	30.71	28.78	32.23	36.16	......	37.89	30.92	41.98	34.19
45.21	41.97	46.30	44.44	44.03	43.57	42.55	44.03	46.42	......	45.53	42.23	47.96	45.98
40.82	41.27	44.35	43.78	42.33	44.33	41.58	42.49	43.98	......	42.56	42.91	43.35	43.35

ed. ‡ Not used in computing yearly means.

TABLE

Mean temperature at Johnstown Academy, Johnstown, Fulton

MONTH.	1828.	1829.	1830.	1831.	1832.	1833.	1834.
December	†23.98	31.96	‡37.33	†23.98	15.90	‡28.08	†23.[illegible]
January	27.58	20.58	....	19.00	23.15	....	17.[illegible]
February	31.60	18.35	....	20.59	22.81	....	31.[illegible]
March	34.40	29.98	....	37.16	31.04	....	33.[illegible]
April	40.98	42.95	....	48.61	43.71	....	47.[illegible]
May	57.17	61.26	....	59.29	53.96	....	54.[illegible]
Mean	35.95	34.18	....	34.82	31.68	....	34.[illegible]
June	70.38	64.76	....	71.05	65.70	....	62.[illegible]
July	68.20	65.98	....	69.04	68.22	....	73.[illegible]
August	71.93	65.24	....	69.24	68.94	....	67.[illegible]
Mean	70.17	65.33	....	69.78	67.62	....	67.[illegible]
September	55.97	55.51	....	60.29	58.40	....	[illegible]
October	46.69	52.19	....	50.11	49.43	....	43.[illegible]
November	37.91	38.18	....	31.82	37.92	....	33.[illegible]
Mean	46.86	48.63	....	47.41	48.58	....	45.[illegible]
Yearly mean	47.23	45.58	....	46.65	44.89	....	45.[illegible]

* From State meteorology. † Mean of thirteen

lo. 20.

inty, N. Y., for the years indicated, from 1828 *to* 1845, *inclusive.**

35.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.
21.93	17.41	23.92	24.53	‡18.28	....	†23.98	32.00	22.71	11.71	25.19	23.08
18.28	20.94	14.31	26.16	....	....	27.80	27.21	26.79	5.78	22.67	21.27
17.34	13.95	22.79	13.79	....	....	24.13	33.07	16.04	23.26	22.09	22.11
30.21	22.01	25.88	35.74	....	....	31.15	39.76	23.59	32.85	33.87	31.50
41.14	38.62	39.77	36.86	....	....	35.27	48.98	44.23	52.37	42.08	43.08
55.23	57.26	52.43	53.59	....	....	53.85	53.82	57.57	57.73	51.30	55.66
30.69	28.36	29.84	31.78	....	....	32.70	39.14	31.82	30.62	32.87	32.78
34.60	62.88	64.26	69.40	....	....	69.72	62.20	55.48	65.25	63.76	65.16
57.60	70.64	70.70	70.74	....	....	66.78	68.47	69.96	68.95	67.69	69.00
51.98	63.38	65.24	71.32	....	....	67.48	68.03	71.64	63.04	69.15	67.80
34.73	65.63	66.73	70.49	....	....	67.99	66.23	65.69	67.41	66.87	67.32
53.[illegible]0	59.33	58.66	63.42	....	....	56.54	56.36	62.32	61.70	54.02	58.24
49.81	40.76	45.78	45.62	....	....	45.17	45.75	45.04	44.89	47.11	46.59
34.47	34.07	36.91	30.30	....	....	37.64	32.40	24.49	33.42	38.55	34.39
45.99	44.72	47.12	46.45	....	....	46.45	44.84	43.95	46.67	46.56	46.41
43.02	41.77	43.38	45.12	....	....	44.96	47.34	43.32	43.83	44.79	44.82

ars. ‡ Not used in computing yearly means.

thorough study of the runoff of streams in relation to rainfall, we will refer to these data somewhat at length, beginning with a discussion of the results obtained on the experiment farm of Sir J. B. Lawes, at Rothamsted, England.*

Drain Gages at Rothamsted.

As stated in the beginning of their paper On the Amount and Composition of Rain and Drainage Waters Collected at Rothamsted, the distinguished authors, Messrs. Lawes, Gilbert and Warrington, have collected together the results of all the investigations relating to the rain and drainage waters of Rothamsted up to the date of the paper (1881). Passing the introductory portion of the paper we will describe the methods used for determining rainfall. In order that this determination might be accurately made a rain gage was constructed with an area of 7.25 feet by 6 feet, or 43.56 square feet, equal to exactly one one-thousandth of an acre. The depth of the rainfall has also been kept with an ordinary rain gage, and the results of the two are available for comparison. The record shows that the large gage gives considerably more water than an ordinary small gage. Taking the mean of the 28 years from 1853 to 1880, inclusive, it is found that the mean rainfall, as determined by the large gage with an area of one one-thousandth of an acre, is 28.30 inches, while, as per the small gage, the mean rainfall is 25.53 inches. The mean difference of the 28-year period is 2.77 inches, amounting to 9.8 per cent. Examining the tabulation of these results in detail, it appears that the agreement between the two gages is much better in the summer months than during the winter. The least difference occurs in July, when, as a mean for the whole 28-year period, we have 2.70 inches for that month as per the large gage, and 2.53 inches as per the small gage, the difference of the two being 0.17 inches. The largest difference occurs in March, for which month the means of the 28-year period are, as per the large gage, 1.69 inches, and as per the ordinary gage, 1.4 inches, the dif-

*Paper On The Amount and Composition of the Rain and Drainage Waters Collected at Rothamsted. By J. B. Lawes, J. H. Gilbert and R. Warrington. Journal of the Royal Agricultural Society, England. (Sec. ser.) vol. XVII, parts I and II (1881), pp. 241-279, and 311-350.

ference being 0.29 inches. As to the causes contributing to this difference the authors state that they are tolerably manifest. A heavy snowfall is much better retained by the large gage than by the small. Deposits of mist, dew and hoar frost are also distinctly greater with the large gage. The increased difference between the gages during the winter months thus admits of explanation, while the difference in summer is not so easily accounted for. Taking into account the indications of the different sized gages used at Rothamsted, we may conclude that, with a mean rainfall of 28 to 30 inches, the rainfall records, kept with the ordinary 10-inch gage commonly used, may be in the vicinity of 10 per cent. too small. The larger part of the difference occurs in the winter months.

The drain gages used at Rothamsted are three in number, consisting of rectangular plats of uncropped soil, each 6 feet by 7.25 feet, and thus having the same area as that of the large rain gage, namely, one one-thousandth of an acre. In the first gage the depth of soil is 20 inches; in the second, 40 inches, and in the third, 60 inches. As stated by the authors, in order to obtain a natural drainage it was of primary importance that the soil should be in a perfectly natural condition, neither more porous or compacted than ordinary field-soil. To accomplish this a deep trench was excavated along the front of each gage, the layers of soil then gradually undermined and plates of cast-iron, perforated with holes, introduced to support the soil. As the work proceeded these plates were finally introduced under the entire area and properly supported. After supporting the soil thoroughly from beneath, trenches were made, one by one, on the three remaining sides of the block of soil to be isolated, and walls of brick, laid in cement, built up from the bottom. The necessary arrangements for catching the drainage were then built beneath and everything made tight by thorough cementing and refilling the trenches on the outside of the walls. Tables giving the results obtained from these drain gages may be found in the original paper in the Journal of the Royal Agricultural Society and also in papers before the Institution of Civil Engineers.* In

*See paper On the Subterranean Water in the Chalk Formation of the Upper Thames and its Relation to the Supply of London. By John Thornhill Harrison, M. Inst. C. E. Proc. Inst. C. E. vol. CV. (1891) pp. 35-46.

the original paper, in the Journal of the Royal Agricultural Society, the results are given for the calendar year, but, in the discussion of Mr. Harrison's paper before the Institution of Civil Engineers, we find them arranged for a water year, beginning with September and ending with August, which more clearly fits the conditions of runoff of English climate than does a tabulation by calendar years.

The following gives the results for the twenty years from 1870–71 to 1889–90, the rainfall being that of the large gage and the drainage through the soil that of the drain gage with 40 inches in depth of soil. The evaporation is the difference of the rainfall and the drainage through the 40-inch gage.

Year.	Rainfall. in inches.	Drainage through 40-in. gage, in inches.	Evaporation.
1870–71	27.55	9.42	18.13
1871–72	29.02	9.39	19.63
1872–73	30.66	13.67	16.99
1873–74	21.69	5.40	16.29
1874–75	31.61	12.72	18.89
1875–76	31.98	16.87	15.11
1876–77	39.28	22.07	17.21
1877–78	32.65	16.44	16.21
1878–79	41.05	26.03	15.02
1879–80	21.36	7.39	13.97
1880–81	36.77	22.84	13.93
1881–82	32.31	16.08	16.39
1882–83	34.71	21.72	12.99
1883–84	25.77	12.0	13.77
1884–85	26.78	15.14	11.64
1885–86	31.02	18.41	12.61
1886–87	23.61	12.58	11.03
1887–88	30.50	15.58	14.92
1888–89	30.09	15.82	14.27
1889–90	27.43	13.60	13.83
Averages	30.29	15.16	15.13

Persistency in Evaporation.

In studying these results one is struck first of all with the fact that evaporation, with a few exceptions, is a fairly constant quantity. For instance, the mean evaporation for the twenty-year period covered is 15.13 inches. The maximum is 19.63 inches and the minimum 11.03 inches. We learn then that the maximum is only 4.50 inches greater than the mean, and the minimum 4.10 inches less than the mean. As stated by the authors of the paper, the large evaporation credited to the first one or two years is probably due to error in the results for those two years. The drain gages were constructed during the exceedingly dry summer of 1870, and the blocks of soil, isolated by cutting trenches around them, were necessarily, more or less, exposed on all their sides. It is probable that a year or two elapsed before the soil of the drain gages absolutely resumed its natural condition. If we were to make correction of the results with this understanding we would so reduce the maximum that its excess above the mean would be about the same as the deficiency of the minimum below the mean.

According to Messrs. Lawes, Gilbert and Warrington the comparative constancy of the evaporation under very different climatic conditions is remarkable; they consider it largely due to the fact that the two principal conditions which determine a large evaporation, namely: Excessive heat and abundant rain, very rarely occur together. As regard English climate in a wet season, when the soil is kept well supplied with water, there is at the same time a more or less saturated atmosphere with an absence of sunshine, which gives conditions unfavorable to large evaporation. In a hot season, on the other hand, there is usually a scarcity of rain, and, after the surface of the soil has become dry, evaporation proceeds only very slowly.

On examining the detailed results given at the place cited, it appears that evaporation is by no means as regular during the winter as in the summer. As might naturally be expected there are variations due to freezing at the surface, etc., making greater irregularities in that season. There are also times when the drainage during a month has been greater than the rainfall. The authors

consider that this is generally due to rain or snow falling at the end of one month and appearing as drainage in the next. It also occasionally happens in severe winters that a considerable amount of frozen water is retained in the upper layers of the soil for some time, only appearing as drainage when the spring breakup takes place. Messrs. Lawes, Gilbert and Warrington offer another explanation, namely: The condensation of water by the soil directly from the atmosphere. They point out that such condensation must take place whenever the temperature of the soil is below the dew point of the atmosphere. Thus during a clear frosty night both rain gage and soil condense water from the atmosphere, the soil, perhaps, somewhat the more. It also seems probable that after a long continued frost, followed by mild weather, the soil continues for some time to condense from the air appreciable quantities of water, of which the rain gage gives no account. The authors are of the opinion that such condensation has affected the record in the winters of 1878–79 and 1879–80. As regards the climate of England, however, they are disposed to say that, save in exceptional seasons, the total amount of water obtained from the atmosphere without affecting the records of the rain gage is not large, although it is clear there may be humid climates such as the timber regions of some portions of this country where such condensation would be with certain soils considerable. On this point consider Schübler's results already cited.

The mean temperature at Rothamsted, where these records have been kept, is about 48° F. As shown by the foregoing tabulation, the mean evaporation of this locality, from 40 inches in depth of uncropped soil amounts to 15.13 inches, the mean rainfall being 30.29 inches.

Drain Gages at Nash Mills.

In the discussion of Mr. Brathwaite's paper on the river Wandle, read before the Institution of Civil Engineers in 1861,* Mr. John Evans gave the results of twenty-seven years experiments with the

*On the Rise and Fall of the River Wandle; its Springs, Tributaries and Pollution. By Frederick Brathwaite, M. Inst. C. E. Proc. Inst. C. E. vol. XX (1860–61).

drain gages kept at Nash Mills, Hertfordshire, England, for the years 1833-34, to 1859-60, inclusive. Without going into the detail we may present the following averages of Mr. Evans' gages for the years stated, first remarking that he divides the year into a winter and summer period, the winter period beginning with October and ending with March, and summer beginning with April and ending with September. Throwing out the records of the first two years, Mr. Evans gives the following average of the eighteen-year period from 1835-36 to 1852-53: Winter rain, 13.86 inches; winter percolation, 8.64 inches. Summer rain, 12.79 inches; summer percolation, 0.55 inches. The annual average at Nash Mills for eighteen years was 26.65 inches of rain and 9.19 inches percolation. For the twenty-five-year period from 1835-36 to 1859-60, the winter rain was 13.32 inches; percolation, 7.51 inches. For the same period the summer rain was 13.29 inches and the percolation 0.72 inches. The annual averages for the entire period were: Rain, 26.61 inches; percolation, 8.23 inches. The detail as to the gages at Nash Mills may be found in the paper in the Proceedings of the Institution of Civil Engineers, already cited.

As another interesting paper on the same general subject, we may refer to Mr. Evans' paper, also before the Institution of Civil Engineers.*

In this paper, Mr. Evans gives full information as to the drain gages kept at Nash Mills for the period of fifteen years from 1860-61 to 1874-75. Detailed tabulations are given of the rainfall and percolation through ordinary soil and chalk for this period. As regards percolation through chalk, Mr. Evans' tables indicate somewhat greater percolation than through soil, and while his results in this particular are not especially applicable to our case, they are still of value as indicating the great difference in the amount of water percolating through soils of different characteristics. The average annual rainfall for the whole period covered was 26.49 inches; percolation through soil, 5.75 inches, and through chalk, 9.87 inches. This paper also includes an interesting

*On the Percolation of the Rainfall in Absorbent Soils. By John Evans, F. R. S. Asso. Inst. C. E. Proc. Inst. C. E. vol. XLV, pp. 208-216.

discussion as to the depth to which water must penetrate in soil before passing beyond the reach of atmospheric influences, which for lack of space can not well be abstracted here. The conclusion of the author is, however, that the amount of percolation is more dependent upon the time at which the rain falls and the manner of its distribution than on the actual quantity of the rainfall.

Drain Gages at Lea Bridge.

As further interesting data relating to evaporation and percolation, we may refer to a paper by Mr. Graves,* in which we find given the results of measurements of rainfalls, percolation and of evaporation from a water surface, observed at Lea Bridge, in the valley of the river Lea. Mr. Graves' gages were of the Dalton pattern, and constructed as follows: A strong slate open-topped water-tight box or tank, with an area of one square yard and thirty-six inches in depth, has connected to the middle of its bottom a lead pipe which leads to a fixed vessel with a close bottom set upright as a reservoir and with its base placed several feet below the tank. A glass gage pipe is fitted to the side of the reservoir, with stop and outlet cocks and a graduated scale, and the whole of the reservoir protected from frost. The slate tank is sunk into the ground, the inside of the bottom lightly covered with cement to the height of the outlet pipe, and the tank filled with soil or earth to within two inches of the top. The soil is turfed over, kept level, and the grass occasionally cut. Mr. Graves' rainfall observations have been made by a rain gage of the same area as the drain gages, or one square yard. In addition to the gage filled with soil the observations include, since 1860, a similar gage filled with sand, which was established in order to measure maximum percolation. The sand is underdrained the same as the soil, and is therefore never in a state of saturation.

The following are some of Mr. Graves' results:

Rainfall for 22 years............................	25.84 inches
Percolation through the ground for 22 years.........	6.87 inches
Evaporation from the ground for 22 years..........	18.97 inches

*On Evaporation and On Percolation. By Charles Graves, M. Inst. C. E. Proc. Inst. C. E. vol. XLV.

Rainfall for 19 years............................	25.73 inches
Percolation through the ground for 19 years........	7.0 inches
Evaporation from the ground for 19 years.........	18.74 inches

Rainfall for 14 years............................	25.72 inches
Percolation through the ground for 14 years.......	7.58 inches
Evaporation from the ground for 14 years.........	18.14 inches
Evaporation from water surface for 14 years......	20.60 inches
Evaporation from sand for 14 years..............	4.31 inches

The summary of Mr. Graves' results for fourteen years, all in inches, appears in the following:

YEAR.	PERCOLATION.			EVAPORATION.		
	Rainfall.	Ground.	Sand.	Ground.	Sand.	Water.
1860	32.56	10.76	23.46	21.80	9.10	21.05
1861	23.63	5.71	16.36	17.92	7.27	25.01
1862	26.58	8 55	21.18	18.03	5.40	17.33
1863	19.77	8.76	16.41	16.01	3.36	18.27
1864	15.89	3.82	12.64	12.07	3.25	18.64
1865	29.25	11 15	27.82	18.10	1.43	20.12
1866	31.70	12.59	28.11	19.11	3.59	18.92
1867	27.44	5.16	22.42	22.28	5.02	20.06
1868	23.31	7.11	20.20	16.20	3.11	26.93
1869	24.56	8.05	22.14	16.51	2.42	19.06
1870	20.40	7.23	18.70	13.17	1.70	20.40
1871	24.08	6.19	20.08	17.89	4.00	19.58
1872	37.17	12.03	30.05	25.14	7.12	22.92
1873	23.77	4.05	20.12	19.72	3.65	20.40
Mean	25.72	7.58	21.41	18.14	4.31	20.61

The foregoing figures show the great difference in water yielding capacity of sand areas as compared with ordinary compact soils. The mean rainfall for fourteen years was 25.72 inches, of which 7.58 inches percolated through the ground and 21.41 inches through sand. The loss from evaporation from the ground averaged for the period 18.14 inches, and only 4.31 inches from sand. It is results of this character which enforce upon us the importance of knowing the character of the soil of the watershed as a necessary part of any study of the runoff. Such results also enforce the proposition that with large drainage areas where many different kinds of soils may be found the problem of the relation of the runoff to the rainfall becomes so complicated as to render any-

thing other than general conclusions impossible. It is not intended to claim, however, that these figures have any further significance than to guide the judgment when studying specific problems. The sand used by Mr. Graves although described as fine was undoubtedly free from clay or anything else likely to interfere with the passage of water. Sand areas, when much clay and loam is intermixed, frequently have large evaporative power, as for instance the Cochituate drainage area discussed further on.*

THE EFFECT OF FORESTS ON RAINFALL.

There has recently been considerable discussion as to the effect of forests upon rainfall and the proposition that forests have any material effect upon rainfall has been frequently denied. A curious instance of such effect is given in the discussion of Mr. O'Connell's paper referred to in the foot note. The statement is made that the western Ghauts mountains in India, which run parallel to the coast at a distance of from fifty to sixty miles have a pass in

*In addition to the reference already given as to information about percolation we may refer to the following:

Dr. Dalton, Mem. Lit. and Phil. Soc. of Manchester, vol. V. part II (1797-1798).

Mr. Dickinson, Jour. Agric. Soc. vol. V. Experiments made in 1836-43.

M. Maurice, Bibl. Universelle de Geneve, Science et Arts. vol. I.

M. Gasparin, South of France, Cours d' Agriculture, vol. II. p. 116.

M. Risler, Archives des Sciences de la Bibliotheque Universelle. September, 1869.

(The foregoing has been condensed from list in Proc. Inst. C. E. vol. 45, p. 56.)

Questions of Percolation in Relation to Rainfall and Evaporation were also discussed extensively before the Royal Commission on Metropolitan Water Supply (1893). See volume of appendices to the report of that commission, pp. 645-670. The large amount of detailed information given renders presentation of it impossible here.

As further papers bearing upon the general question of the relation of the discharge of streams to rainfall, the following may be consulted:

On Rainfall, Natural Drainage and Subterranean Water Storage. By Professor D. T. Ansted, Jour. Royal Agric. Soc. (Sec. ser.) vol. II, pp. 62-78; vol. III, pp. 65-86.

On the Discharge from Underdrainage and Its Effect on the Arterial Channels and Outfalls of the Country. By John Bailey Denton, M. Inst. C. E. Proc. Inst. C. E. vol. XXI (1861-62), pp. 48-181.

On the Relation of the Fresh Water Floods of Rivers to the Areas and Physical Features of Their Basins; and on Method of Classifying Rivers and Streams With Reference to the Magnitude of Their Floods; proposed as a means of facilitating the investigation of the laws of drainage. By Lieut.-Col. Peter Pierce, Lyons O'Connell, R. E, Assoc. Inst. C. E. Proc. Inst. C. E. vol. XXVII (1867-68), pp. 204-273. This paper gives in an appendix a table exhibiting the physical features of a number of the principal rivers of the world.

The Nagpur Waterworks; with Observations on the Rainfall, the Flow From the Ground, the Evaporation at Nagpur; and on the Fluctuation of Rainfall in India and other places. By Alexander R. Binnie, Mem. Inst. C. E. vol. XXXIX (1874-75), part I, pp. 1-61.

them forty miles in width through which the railway from Madras to the west coast is taken at a level of 1,200 feet above the sea. About twenty miles below the crest of this slope, the railway leaves a dry bare looking country and dashes at once into a rich bamboo jungle with luxuriant vegetation. Observation has shown that although the southwest monsoon passes with full force through this gap in the range, the rain stopped short at the line of this jungle; so strongly marked is this, that at the distance of only a few hundred yards to the west of the line there is probably at times sixty inches of rainfall in three months, while at the same distance on the east side of the line the depth frequently does not exceed six inches. Mr. O'Connell states that different explanations have been made by meteorologists, but for a long time none of them were satisfactory. At length reference to the collector of the district elicited the fact that the line of no rain had traveled back a distance of seven miles in the course of twelve years, such distance representing apparently the clearing up of the forest, the result being that when the ground was laid bare to the action of the sun the rain ceased. Upon reflection Mr. O'Connel says this would be easily understood as the necessary result. The sun, during the monsoon, is almost vertical and shines down upon the dry bare soil creating by the reflection of its heat an upward stream of hot dry air, which, encountering the rain, turned it into vapor which was carried away by the southwest wind, depositing it here and there when it passed over forest land but never descending again in any body until it reached the Bay of Bengal. Mr. O'Connel remarks that the same cause would produce the same effect in any country similarly situated, but he would not consider it safe to lay down the general rule applicable to all countries that the destruction of forests would be followed by similar results.

In the discussion of Mr. Denton's paper on the Discharge from Underdrainage, etc., a reference to which is also given in the footnote, page 831, it was remarked by Mr. Bidder, past president of the Institution of Civil Engineers, that evaporation from a drainage area could not be measured by taking the difference between the rainfall and the runoff of a stream.

Mr. Bidder asserted positively that the evaporative power of the soil can not be measured, because it depends upon such a variety of circumstances. As an illustration, he cites the case of a turnpike road, where, in a very hot time, there is little or no evaporation, but if the road is watered two or three times a day the applied water is all evaporated. Hence, in quoting experiments which show that the evaporation exceeds the rainfall, all that can be said is that the evaporative power of the ground only is shown. It would not be correct from that to assume a definite relation between evaporation and runoff, etc.

THE SIGNIFICANCE OF PERCOLATION DATA.

In considering the significance of the percolation experiments, we may further note that while under the special conditions of the experiments, the entire precipitation has either percolated or been evaporated, still, in actual experience with drainage areas, there is a certain indeterminate portion of the total rainfall which runs off on the surface, reaching the streams in that way. In applying the data of the foregoing percolation experiments to stream flow problems, this distinction should be kept in view.

THE RUNOFF OF THE SUDBURY RIVER, LAKE COCHITUATE AND THE MYSTIC RIVER.

In the foregoing, we have presented a large amount of general data applying to the problem of the runoff of streams in relation to evaporation and rainfall. Let us now consider the specific cases of the runoffs from the Sudbury river, Lake Cochituate and Mystic river drainage areas.

According to Mr. Fitzgerald* the Sudbury river has a drainage area of 75.2 square miles, the Mystic, 26.9 square miles, and the Cochituate, 18.9 square miles; they together forming the present source of Boston's water supply. The Sudbury is hilly, with steep slopes, with some large swamps within its borders. The Cochituate, although adjoining the Sudbury, is entirely dissimilar. The slopes

*Paper on Rainfall, Flow of Streams and Storage. By Desmond FitzGerald, M. Am. Soc. C. E. Trans. Am. Soc. C. E. vol. XXVII (September, 1892), pp. 267-8.

are flat and sandy, with its surface mostly modified drift, while the Sudbury is mostly composed of unmodified drift. The Mystic watershed lies to the north of Boston, about thirty miles distant from the Sudbury and Cochituate, which are from twenty to thirty miles northwest of the city. The surface of the Mystic watershed is steeper than the Cochituate and less steep than the Sudbury.

Sudbury River.

In Table No. 21,* we have the mean temperature, precipitation, runoff and evaporation of the Sudbury watershed, for the twenty-one years from 1875 to 1895, inclusive. Examining Table No. 21, in detail, it is learned that the water year of 1893 was the year of minimum rainfall for the entire twenty-one years covered. The storage rainfall for that year was 16.78 inches; growing period rainfall, 5.81 inches, and the replenishing rainfall 8.93 inches, giving a total of 31.52 inches for the whole year. The runoff of the year 1883 was, for the storage period, 9.70 inches; for the growing period, 0.86 inches, and for the replenishing period, 0.84 inches, giving a total of 11.40 inches for the whole year. It appears, then, that the year 1883, in addition to being the year of minimum rainfall, was also a year of minimum runoff. The evaporation for 1883 was as follows: Storage period, 7.08; growing period, 7.95 inches, and replenishing period, 8.09; total evaporation for the year, 20.12 inches.

The year 1880 may also be referred to as a year of low runoff. In that year the storage runoff was 11.19 inches; growing period runoff, 0.83 inches; and the replenishing runoff, 0.67 inches; total for the whole year was 12.69 inches; the rainfall for the whole year was 37.70, and the evaporation, 25.01 inches.

Lake Cochituate.

In Table No. 22, we have the mean temperature, precipitation, runoff and evaporation of the Lake Cochituate watershed, from

* The data embodied in Tables Nos. 21, 22 and 23, have been mostly either derived from the annual reports of the Boston works, or furnished in manuscript by Mr. FitzGerald, to whom the survey is greatly indebted for many courtesies. The mean temperatures from Cambridge and Boston have been obtained from the Weather Bureau, United States Department of Agriculture.

1863 to 1896, inclusive, a period of thirty-three years; 1883 was also the year of minimum rainfall and runoff on the Cochituate, the same as on the Sudbury watershed. The rainfall was, for the storage period, 16.62 inches; growing period, 5.08 inches; replenishing period, 8.53 inches; giving a total of 30.23 inches for the water year. The runoff was 8.31 inches for the storage period; 0.16 inches for the growing period; and 1.62 inches for the replenishing period; the total runoff of the year being 10.09 inches. The yearly evaporation was 20.14 inches. The year 1880 was also a year of low runoff on the Cochituate, the totals for that year being, rainfall, 36.87 inches; runoff, 10.73, and the evaporation, 26.14 inches.

Mystic River.

Table No. 23 gives the mean temperature, precipitation and evaporation of the Mystic river watershed for the 18-year period from 1878 to 1895, inclusive. The year 1883 was also a year of minimum rainfall and runoff on the Mystic area, the same as on the Sudbury and Cochituate. For the storage period, the rainfall was 16.24 inches; growing period, 5.29 inches; replenishing period, 8.93 inches; total for the year, 30.46 inches. The runoffs were — storage period, 7.41 inches; growing period, 1.04 inches; replenishing period, 0.99 inches; total for the year, 9.44 inches. The total evaporation for the year was 21.02 inches. We learn, therefore, that the total runoff of the water year of 1883, was less for the Mystic area than for either the Sudbury or Cochituate.

The year 1880 gave a total rainfall on the Mystic area of 35.66 inches, with a runoff of 12.31 inches. The total evaporation for the year was 23.05 inches.

Summary for the Sudbury, Cochituate and Mystic Areas.

The following tabulation gives the means of the precipitation, runoff and evaporation for the periods included in Tables Nos. 21, 22 and 23. It will be noticed that the largest mean runoff is on the Sudbury, where we have 22.26 inches, with a mean rainfall of 45.86 inches. The mean evaporation on the Sudbury area is 23.60 inches.

On the Cochituate area the mean rainfall for 33 years is 46.83 inches, or 0.97 inches greater than the mean of the Sudbury. The mean runoff, however, is 20.40 inches, or 1.86 inches less than the mean runoff of the Sudbury. For the Mystic we have a mean rainfall of 44.07 inches, a mean runoff of 19.94 inches, and a mean evaporation of 24.13 inches. A comparison of the means of the Sudbury, Cochituate and Mystic areas is given by the following tabulation:

PERIOD.	SUDBURY.			COCHITUATE.			MYSTIC.		
	Rainfall.	Runoff.	Evaporation.	Rainfall.	Runoff.	Evaporation.	Rainfall.	Runoff.	Evaporation.
Storage	23.28	17.58	5.70	23.08	14.89	8.19	22.41	15.08	7.33
Growing	10.86	1.66	9.20	11.44	2.14	9.30	10.85	2.25	8.60
Replenishing	11.72	3.02	8.70	12.31	3.37	8.94	10.81	2.61	8.20
Total	45.86	22.26	23.60	46.83	20.40	26.43	44.07	19.94	24.13

Tables Nos. 21, 22 and 23 also include the mean monthly temperature of the several drainage areas so far as they are available, together with the mean temperatures of each period of the water year, and the mean temperature of the watersheds for the entire period covered.

A comparison of the mean temperature with the observed runoffs of these three streams from year to year has not thus far yielded an indication of any clear relationship between the two. If there is any such relation it is so far obscured by the many minor modifying influences as to be somewhat difficult of demonstration. It is not considered that this part of the study is entirely complete, but will be given further consideration at some future time.*

The low runoffs of the years 1880 and 1883, as shown by Tables Nos. 21, 22 and 23, may well make us conservative in estimating the minimum yields of either small or moderate size drainage areas in the eastern part of the United States. Considering the lengths of the periods included in these tables, we may lay it down as a

* As stated in the foregoing, the general study of water surface evaporation data show some relation to temperature. The statement just made as to the relation of runoff to temperature is intended to apply only to the Sudbury, Cochituate and Mystic areas.

TABLE

Mean precipitation on the

(In in

MONTH.	Albany, 1825–1895. Mean of 69 years.	Glens Falls, 1879–1895. Mean of 17 years.	Keene Valley 1879–1895. Mean of 17 years.	Western Mass. 1887–1895. Mean of 8 years.
December	2.71	3.19	2.75	4.31
January	2.75	3.16	3.00	3.36
February	2.49	3.03	2.22	2.83
March	2.72	2.72	2.24	2.94
April	2.80	2.15	2.09	2.02
May	3.62	3.10	3.05	3.17
Total	17.09	17.35	15.35	18.63
June	4.07	2.83	2.89	3.24
July	4.29	3.25	3.61	3.44
August	3.96	4.17	4.21	3.91
Total	12.32	10.25	10.71	10.59
September	3.43	2.96	3.00	3.51
October	3.58	2.36	2.49	3.41
November	3.08	3.24	3.56	2.84
Total	10.09	8.56	9.05	9.76
Yearly total	39.50	36.16	35.11	38.98

No. 24.

Jpper Hudson watershed.

es.)

orthern 'lateau, 89-1895. Iean of years.	Lowville Academy, 1827-1848. Mean of 19 years.	Johnstown Academy, 1828-1845. Mean of 15 years.	Cambridge Academy, 1827-1839. Mean of 13 years.	Fairfield Academy, 1828-1849. Mean of 18 years.	Granville Academy, 1835-1849. Mean of 15 years.	Mean of all.	Mean of Albany, Glens Falls and Keene Valley, 1879-1895.
3.57	2.14	2.91	2 36	2.78	2.48	2.92	3.01
3.88	2.35	3.30	3.36	2.69	2 08	2.99	3.03
3.60	2 43	2.86	2.61	2.06	1.42	2.56	2 64
2.52	1.78	3.63	2.12	2.36	1 74	2.48	2.50
2.39	1.91	2.93	3.36	2.53	2.13	2.43	2.14
4.46	2 79	3 45	3.65	3.04	3.47	3.38	3.14
20.42	13 40	19.08	17.46	15.46	13.32	16.76	16 47
3.88	3.42	4.20	4.66	4.29	3 21	3.67	2.99
3.83	3.67	4.01	3 91	4.21	3.63	3.78	3.53
5.07	2.85	3.14	3.98	3.66	2.97	3.79	4.20
12 78	9.94	11.35	12.55	12 16	9.81	11.25	10.75
3.57	2.84	2.87	3.27	3.08	2.67	3.12	3.13
3.06	3.29	3.29	3.60	3 56	2 90	3.15	2 60
3.46	2.94	3.33	3.29	2.46	2 88	3 11	3.26
10.09	9 07	9 49	10.16	9 11	8 45	9 38	8.99
43.29	32.41	39.92	40.17	36 73	31.58	37.39	36.22

TABL

Mean temperature of th

MONTH.	Albany. 1825–1856. Mean of 31 years.	Albany. 1878–1895. Mean of 17 years.	Glens Falls 1878–189 Mean of 17 years.
December	28.29	29.20	25.5
January	24.48	23.40	19.
February	25.07	25.00	21
March	34.72	32.00	30.4
April	47.33	46.60	46.
May	59.60	59.80	60.9
Mean	36.58	36.00	34.1
June	68.14	69 00	69.4
July	72.53	72.50	72.
August	69.88	70.60	70.5
Mean	70.18	70.70	70.
September	61.64	63 70	63.1
October	49.83	51.20	50.7
November	39.43	39.70	37.7
Mean	50.30	51.50	50 4
Yearly mean	48.41	48.50	47.4

No. 25.

pper Hudson watershed.

)

Keene Valley. 78–1895. ean of years.	Fairfield Academy, 1827–1849. Mean of 19 years.	Lowville Academy, 1827–1848. Mean of 19 years.	Johnstown Academy, 1828–1845. Mean of 14 years.	Granville Academy, 1835–1849. Mean of 15 years.	Cambridge Academy, 1827–1841. Mean of 14 years.	Mean of all.	Mean of Albany, Glens Falls and Keene Valley, 1878–1895. 17 years.
23.50	22.83	23.83	23 08	24.68	26.10	25.22	26.10
19.10	19.86	20.10	21.27	20.67	22.44	21.17	20.60
20.60	20.44	20.68	22 11	20.09	21.45	21.89	22.40
27.40	29.58	29.67	31.50	31.29	32.69	31.03	29.90
40.40	41.72	44.28	43.08	43 63	44.19	44 23	44.60
54.40	53.53	55.00	55.66	56.15	55.99	56.78	58.40
30.90	31.33	32.26	32.78	32.75	33.81	33.39	33.70
63.40	62.54	62.99	65.16	66 49	64.82	65.77	67 30
66.10	66.07	67.88	69.00	70.82	68.88	69.59	70.40
63 70	65.64	65.23	67.80	68 28	66.09	67.52	68 30
64.40	64.75	65.37	67.32	68.53	66.60	67.63	68.60
57 30	57.82	57.27	58.24	58 72	58.29	59.56	61.40
45.20	45.94	45.84	46.59	47.70	46.76	47.73	49 00
34.00	34.19	34 09	34.39	35.88	36.56	36.22	37.10
45.50	45.98	45.74	46.41	47.43	47.20	47 84	49.10
42.90	43.35	43.91	44.82	45.37	45 35	45.56	46.3

TABLE

Mean monthly precipitation at Albany, Glens Falls

(In inc

MONTH.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
December	6.17	3.37	1.51	4.65	2.12	1.90	3.39
January	2 27	2.81	2.56	1.87	2.45	2.58	3 61
February	2.57	2.29	2.43	2.33	2.54	3.72	2.13
March	3.53	2.15	3.31	3.09	1.84	3.73	1.10
April	2.49	2.38	1.50	1.11	1.85	1.72	2.76
May	0 73	3.17	3.48	2.95	3.76	2.70	2.12
Total	17.76	16.17	14.79	16.00	14.56	16.35	15.11
June	3.57	1.49	2.66	3.59	3.55	1.65	2.61
July	3 66	3.13	2.24	2.64	4.08	3.13	3.03
August	2.69	2.32	2.07	2.52	1.84	4.09	7.68
Total	9.92	6.94	6.97	8.75	9.47	8.87	13.32
September	3.23	3.29	2 84	5 65	3.31	1.60	2.24
October	1.06	3 03	2.80	0.46	2.92	2.01	5.06
November	3.86	3.17	2.51	1.03	2.06	3.33	3.57
Total	8.15	9.49	8 15	7.14	8.29	6.94	10 87
Yearly total	35.83	32.60	29.91	31.89	32.32	32.16	39.30

* This table has been obtained by combining

ᴺo. 26.

ınd Keene Valley, from 1879 *to* 1895, *inclusive.**

es.)

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Mean.
1 86	2.05	4.32	3.04	3.34	2.77	3.77	0.75	3.41	2.73	3.01
3.61	3.51	3.07	4.26	3.11	5.01	4.71	1.98	2.47	1.70	3.03
1.56	3.49	2.35	1.76	3.25	3 82	3.10	4.65	2.38	1.47	2 64
2.56	2.47	4 84	1.32	3.19	3.15	1.92	1.52	1.39	1.40	2 50
3.43	2.52	2.11	1.74	2.00	2.23	1.01	2 24	1.55	3.85	2.14
2.78	1.63	3.11	3.66	4.89	1.92	5.14	5.15	4.34	1.99	3.15
15.80	15.67	19.70	15.78	19.78	18.90	18.65	16.29	15.54	13.14	16.47
2.43	2.91	2.74	6.14	3.22	2.83	4.32	1.84	3.01	2 92	3.03
3.15	6.02	2.12	5.53	1 97	4.47	5.37	3.38	2.40	3.72	3.53
2.57	2.98	5.21	2.44	6.54	4.59	6.63	9.42	2.24	5.54	4.20
8 15	11.91	10.07	14.11	11.73	11 89	16.32	14.64	7.65	12.18	10.76
3.13	1.05	4.57	3.18	5 92	1.48	2.51	2.95	3.70	2.56	3 13
2.31	1.70	4.05	2.84	4.48	2.16	1.41	1.75	4 52	1.58	2.60
5.33	3.91	4.66	4.52	1.87	3.14	3.10	1.29	2.96	5.13	3.26
10.77	6.66	13.28	10.54	12.27	6.78	7.02	5.99	11.18	9.27	8.99
34.72	34.24	43.05	40.43	43.78	37.57	41.99	36.92	34.37	34.59	36.22

:ables Nos. 1, 2 and 3, of the 1895 report.

No. 27.

and Keene Valley, from 1879 *to* 1895, *inclusive.**

)

1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	Mean.
26.7	20.5	24.9	27.7	32.0	16.9	35.6	24.7	23 8	27 9	26.1
18.9	17.8	11.9	28.0	27.5	23 3	22.6	14.3	26.1	22.0	20.6
20.5	22.1	21.2	18.8	28.4	27.0	25.2	21.2	19.8	19.1	22.4
30.8	26.8	26.3	33.5	30.2	31.5	28.7	30.7	39.5	29.2	29.9
48.5	40.9	41.7	47.5	45.8	48.6	45.8	42.9	47.8	46.2	44.6
57.5	63.6	56.6	61.0	56.1	56.6	56.2	58.0	60.2	62.1	58.4
33.8	31.9	30.4	36.1	36.7	34.0	35.7	32 0	36.2	34.4	33.7
64.8	67.7	67.9	66.7	67.5	66.6	70.1	68.3	69.8	71.5	67.3
70.3	74.3	69.0	71.2	69.5	68 4	71.5	70 2	73.4	69.5	70.4
67.1	66.0	68.6	67.8	68.0	70.0	70.0	70.0	67.4	69 8	68.3
67.4	69.3	68.5	68 6	68.4	68.4	70.5	69.5	70.2	70 3	68.6
61.1	57.2	59.2	61.8	60.1	66.0	61.0	57.1	65.6	64.4	61.4
50 0	46.9	41.8	44.8	48.8	48.6	49.5	53.2	51.9	46 0	49.0
37.2	35.8	37.8	40.2	35.9	37.8	37.8	38.1	34.7	39.7	37.1
49.4	46.6	46.2	48.9	48 3	50.8	49.4	49.5	50.7	50.1	49.1
46.1	44.9	43 9	47.4	47.5	46.8	47.9	45.7	48.3	47.3	46.3

tables No. 12 A, 13 and 14, of this report.

general proposition that, in the eastern part of the United States, with drainage areas of from 25 to 100 square miles, with mean rainfalls of from 40 to 46 or 47 inches, we may have in some extremely dry year a minimum runoff as low as about 10 inches over the whole watershed. This statement is made as a rapid generalization merely of the data of Tables Nos. 21, 22 and 23. As to the frequency with which such low runoffs may be expected to occur, reference may be made to the discussion following as to the probable rainfall, etc., of the Upper Hudson area.

THE PRACTICAL VALUE OF RUNOFF DATA.

As a practical point it may be further noted that the deductions here made as to the runoffs of the Sudbury, Cochituate and Mystic watersheds are of the greatest importance in estimating the water supplies of towns. These several watersheds are of about the size constantly required for towns ranging in size from a few thousand inhabitants to three or four hundred thousand.* We should remember, too, that the Upper Genesee river, with a drainage area of 1,070 square miles and a mean annual rainfall about the same as in Massachusetts, gave a minimum runoff in 1895 of 6.67 inches.

THE DETERMINATION OF DRIER YEARS THAN 1891 AND 1895.

Tables Nos. 1, 2 and 3 of the 1895 report give the mean monthly runoffs at Albany, Glens Falls and Keene valley for the seventeen-year period from 1879 to 1895, inclusive.

Tables Nos. 6 and 8 of the same report exhibit the mean monthly runoffs of the Hudson river as determined by the gagings at Mechanicville for the eight years from 1888 to 1895, inclusive. A study of the runoff records indicates that the years 1891 and 1895 were, on the whole, the driest of the eight years covered by Tables Nos. 6 and 8 of the 1895 report. In studying these runoff records the practical question arises whether there has ever been, on the Hudson river, any more extended dry periods than those of 1891 and

*See Mr. FitzGerald's paper On Rainfall, Flow of Streams and Storage.

general proposition that, in the eastern part of the United States, with drainage areas of from 25 to 100 square miles, with mean rainfalls of from 40 to 46 or 47 inches, we may have in some extremely dry year a minimum runoff as low as about 10 inches over the whole watershed. This statement is made as a rapid generalization merely of the data of Tables Nos. 21, 22 and 23. As to the frequency with which such low runoffs may be expected to occur, reference may be made to the discussion following as to the probable rainfall, etc., of the Upper Hudson area.

THE PRACTICAL VALUE OF RUNOFF DATA.

As a practical point, it may be further noted that the deductions here made as to the runoffs of the Sudbury, Cochituate and Mystic watersheds are of the greatest importance in estimating the water supplies of towns. These several watersheds are of about the size constantly required for towns ranging in size from a few thousand inhabitants to three or four hundred thousand.* We should remember, too, that the Upper Genesee river, with a drainage area of 1,070 square miles and a mean annual rainfall about the same as in Massachusetts, gave a minimum runoff in 1895 of 6.67 inches.

THE DETERMINATION OF DRIER YEARS THAN 1891 AND 1895.

Tables Nos. 1, 2 and 3 of the 1895 report give the mean monthly runoffs at Albany, Glens Falls and Keene valley for the seventeen-year period from 1879 to 1895, inclusive.

Tables Nos. 6 and 8 of the same report exhibit the mean monthly runoffs of the Hudson river as determined by the gagings at Mechanicville for the eight years from 1888 to 1895, inclusive. A study of the runoff records indicates that the years 1891 and 1895 were, on the whole, the driest of the eight years covered by Tables Nos. 6 and 8 of the 1895 report. In studying these runoff records the practical question arises whether there has ever been, on the Hudson river, any more extended dry periods than those of 1891 and

*See Mr. FitzGerald's paper On Rainfall, Flow of Streams and Storage.

1895, and if so, how much more severe was such dry period, and what is the probability of a recurrence of the same. Tables 1, 2, 3, 4 and 5 of the 1895 report, to which we have already referred, and the temperature records given by the accompanying tables of this report, together with the additional rainfall data of the present report, furnish the basis for an approximate answer to this question.

As leading to the answer we may formulate the following:

1. Taking into account the distribution of the rainfall, as per Tables Nos. 1, 2, 3, 4 and 5, and stream flow as per Table No. 6, of the upper Hudson survey report of 1895, what is the mathematical probability of less stream flow in some future year than shown by Table No. 6?

2. Find the mathematical probability of the occurrence of a year composed of minimum runoff months.

3. Combine the several records in such manner as to show for the whole drainage area the tendency of the rainfall to run in series of high or low years, at the same time stating the sequence of wet and dry years with regard to the nature of the ultmate minimum runoff.

4. Determine the mathematical probability of drier years than 1891 and 1895, distribution of rainfall and temperature both being taken into account.

TABLE No. 28.

Minimum observed precipitations.

(In inches.)

	Storage period.	Growing period.	Replenishing period.	Water year.
Northern Plateau	15.79	8.78	8.98	36.67
Western Massachusetts	12.37	8.13	4.34	29.71
Cambridge	11.85	6.79	5.23	28.37
Johnstown	18.30	7.75	5.67	30.32
Granville	9.84	3.47	4.49	21.18
Glens Falls	13.07	4.61	5.75	28.06
Keene valley	9.83	6.68	5.00	28.20
Fairfield	6.57	7.43	5 24	25.23
Lowville	7.06	5.78	5.58	26.51
Albany	7.18	6 62	4.97	28.13
Mean	10.69	6.60	5.52	28.24

As preliminary to answering the foregoing propositions, it is necessary to examine the applicability of the method of least squares to rainfall records, and also as to whether high temperatures and heavy rainfalls have a tendency to occur together.

Inasmuch as the available rainfall records are not all cotemporary, but cover periods of different lengths between 1825 and 1896, it has been considered best not to rely upon their mean as being the true mean rainfall of the drainage area, the more especially because several of the stations are not located in the Hudson river drainage area at all. Indeed, the great difficulty of determining the true mean rainfall of this area is lack of observations

TABLE No. 29.

Comparison of observed and computed residuals of given absolute values in the Albany 70-year precipitation record and the combined Albany, Glens Falls and Keene valley records (Tables Nos. 4 and 26).

LIMITS OF ERROR.	ALBANY 70-YEAR RECORD.		COMBINED 17-YEAR RECORD.	
	Observed.	Computed.	Observed.	Computed.
0– 1	9	10.08	2	2.5
1– 2	13	10.15	5	2 3
2– 3	9	9.45	0	2.5
3– 4	9	8.19	3	2.0
4– 5	6	7.49	3	1.7
5– 6	6	6.43	1	1.5
6– 7	5	4.90	2	1.2
7– 8	7	3.92	*1	3.3
8– 9	1	3.08	....	....
9–10	2	2.17	....	....
10–11	0	1.47	....	....
11–12	2	1.05	....	....
Greater than 12	1	1 82	....	....

within the area itself. We are forced of necessity to mostly rely upon stations outside of, but in, its vicinity. It is impossible, therefore, to apportion the proportionate part of the area to which each of these records applies. Hence, by way, merely, of illustrating the method of study to be used, it has been preferred to base the conclusions, for the present, upon the mean rainfall of Albany, Glens Falls and Keene valley, as given by the seventeen-year records.

* Greater than 1.

For this reason, the footings of Tables Nos. 24 and 25 give (1) the means of all the records and (2) the means of the Albany, Glens Falls and Keene valley records separately. Table No. 25 shows the mean temperature of the Upper Hudson drainage area as deduced from the records at Albany, Glens Falls, Keene valley, Fairfield Academy, Lowville Academy, Johnstown Academy, Granville

TABLE No. 30.

Comparison of the variability and precision of the mean of the Upper Hudson precipitations with some other places in the United States.

PLACE.	Number of years' record.	Variability.	Precision of the mean.
		Inches.	Inches.
Albany	17	2.9	0 707
Glens Falls	17	4.6	0.968
Keene valley	17	3.8	0.927
Mean	17	3.03	0.734
Hanover, N. H	19	4 3	1.0
Key West, Fla	19	5.9	1.4
Muscatine, La	18	9.0	2.1
Fort Laramie, Wy	17	6.7	1.9
San Francisco, Cal	17	4.1	1.0
Fort Van Couver, Wash	16	6.7	1.7

Academy and Cambridge Washington Academy. Table No. 26 has been obtained by combining the seventeen-year records of Albany, Glens Falls and Keene valley as given by Tables Nos. 1, 2 and 3 of the 1895 report; while Table No. 27 gives the mean of the Albany, Glens Falls and Keene valley temperature records, obtained by combining the individual records of these three stations.

It will be observed that the monthly means deduced from all the records agree quite closely with those deduced from (2), (3) and (4) of Table No. 25, and either are probably close to the true mean temperature for the stations named.

Referring to Table No. 25, we learn that the mean temperature of the Upper Hudson valley, as deduced from all the records, is 45.56° F.; and the mean of Albany, Glens Falls and Keene valley for the seventeen-year period, 1878 to 1895, inclusive, is 46.3°. Table No. 2 also gives the mean temperature of Saranac lake, for

TABLE

General meteorological characteristi

MONTH.	TEMPERATURE.			
	Maximum in 17 years.	Mean of 17 years.	Variability.	Mean of 17 years.
	(F.°)	(F.°)	(F.°)	(Inches.)
December	35.6	26.1	2.96	3.01
January	29.9	20 6	3.82	3.[illegible]
February	28.4	22.4	3 05	2 64
March	39.5	24.9	2.55	2.5[illegible]
April	48.6	44.6	2.05	2.14
May	63.7	54.6	2.59	3.15
Storage period	37.1	33.7	1.69	16.47
June	71.5	67.3	1.62	3.0[illegible]
July	74.3	70.4	1.03	3 [illegible]
August	70.0	68.3	1.19	4.[illegible]
Growing period	70 5	68.6	0.72	10.76
September	67.7	61.4	2.30	3.1[illegible]
October	56.4	49 0	2.15	2 60
November	40.2	37.1	1.37	3.26
Replenishing period	52.2	49.1	1.05	8 99
Water year	48 3	46.3	1.04	36.22

[N]o. 31.

of the Upper Hudson watershed.

Precipitation.			Runoff.				
…an, as …r cent. of … yearly …ean.	Variability.	Variability as a per cent. of monthly precipitation.	Mean of 9 years.	Mean, as a per cent. of the yearly mean.	Mean, as a per cent. of the monthly precipitation.	Variability.	Variability as a per cent. of the runoff.
	(Inches.)		(Inches.)			(Inches.)	
8.31	0.86	28.6	1.99	8.52	66.1	0.62	31.1
8.36	0.70	23.1	2.17	9.29	71.6	0.80	36.9
7.29	0.59	22.4	1.41	6.03	53.4	0.50	35.5
6.90	0.76	30.4	2.73	11.68	109.2	0.77	28.2
5 91	0.48	22.4	4.67	19.98	218.2	0 87	18 6
8.70	0.86	27.3	3.26	13.95	103 5	1.55	47 5
45.47	1 27	7 7	16.23	69.45	98.5	2.15	13.2
8.36	0.64	21.1	1.50	6.42	49.5	0.48	32.0
9.75	0.83	23.5	0.91	3.89	25.8	0.41	45.2
11.60	1.66	39.5	0.85	3.64	20.2	0.27	31.8
29.71	2.05	19.0	3.26	13 95	30 3	0.92	28.2
8.64	0.80	25 6	0 95	4.06	30 4	0.43	45 3
7.18	0 92	35.4	1.03	4.41	39.6	0.30	29.1
9.00	0.84	25.8	1.90	8.13	58.3	0 45	23.7
24.82	1.62	18.0	3 88	16.60	43 2	0.85	21.9
100.00	3.03	8.4	23.37	100.00	64.5	3.15	13.5

the years 1894-96, inclusive, at 41.2°. It is probable that the mean temperature of the whole region is somewhere between 45.56° and 41.2°. Probably it is about 43° to 44°, but in the absence of more definite data a closer determination can not be made at this time.

Table No. 28 shows the minimum recorded growing, storage, replenishing and yearly rainfall of each of the records in Table No. 24. The final minimum rainfall for the entire watershed will probably be somewhat less than the mean of the minimum shown by Table No. 28.

USE OF THE THEORY OF PROBABILITIES.

In the present study it is assumed that variations from the mean rainfall conform to the requirements of residuals in the method of least squares.

The formulae used in the calculation of probably rainfall and temperature are as follows:

$$p = \frac{2}{\sqrt{\pi}} \int_0^{k\,t} E^{-(k\,t)^2}\, d\,t \qquad (1)$$

$$t = \frac{a}{r} \qquad (2)$$

$$r = 0.8453 \frac{\Sigma \mp \Delta}{\sqrt{n\,(n-1)}} \qquad (3)$$

$$e = 0.8453 \frac{\Sigma \mp \Delta}{n\sqrt{n-1}} = \frac{r}{\sqrt{n}} \qquad (4)$$

In these formulae e and E are constants, with $k = o$, 47694, and $E = 2.71828$, the base of the Naperian system of logarithms; $e =$ the "precision of the mean" or probable error of the arithmetical mean of a series of observations; $n =$ the length of the record in years, or the number of observations; $\Sigma \mp \Delta =$ the sum, regardless

of sign, of the residuals of differences between each observation and the arithmetical mean; $r =$ the "variability" or probable variation from the mean, of a single observation, and $p =$ the probability (certainty equaling 1) that a variation, above or below, the mean having an absolute value not greater than a will occur.

The computations have been made by means of tables giving the value of the integral of formula (1), contained in Chauvenet's Spherical and Practical Astronomy.*

From the probability so determined may readily be computed (1) the probable per cent. of the whole number of years in which the variation from the mean will exceed any absolute value a, and (2) the reciprocal of this value, or the probable average interval between two successive variations from the mean greater than a. These two factors have been used throughout all the tables in the comparison of probabilities, the former being usually designated "probability" and the latter "frequency" or "intervals of recurrence." The latter quantity is always expressed in years.

The formula for probable error of a single year and for precision of the mean are those of Peters, which are generally employed at the present time because of their convenience.†

The law of error expressed in the foregoing integral formula (1) is that of Gauss. It is based on several obvious relations holding strictly true for purely accidental errors, as for instance:

(1) Positive and negative errors of equal absolute value are equally probable, and in a long series equally frequent.

(2) Small errors are more frequent than large ones.

(3) There is a limit to the magnitude of errors.

Various laws of error may be derived conforming to all these fundamental conditions, and strictly speaking, every series of observations no doubt has its own essential law of error.

Variations from the mean rainfall do not answer to the first con-

---

*A Manual of Spherical and Practical Astronomy. By William Chauvenet. See vol II, Appendix, Table IX. Also see article on the Method of Least Squares in the appendix to Vol. II.

†Demonstrations of these formulae as well as of the Law of Error, may be found in Merriman's Theory of Least Squares; Wright's Treatise on the Adjustment of Observations, or Chauvenet's Spherical and Practical Astronomy. Vol. II, Appendix.

TABL

Probability o

Storage Period.				Growing Period.			
Superior limit of rainfall, in inches.	Variation from the mean rainfall, in inches.	Probability, as a per cent. of all years.	Probable interval of recurrence, years.	Superior limit of rainfall, in inches.	Variation from the mean rainfall, in inches.	Probability, as a per cent. of all years.	Probable interval of recurrence, years.
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
16.47	0.0	50.0	2.0	10.76	0.0	50.0	2.
15.47	1.0	29.7	3.4	9.76	1.0	37.0	2.
14.47	2.0	14.5	6.9	8.76	2 0	25.4	3
13.47	3.0	5.6	17.8	7.76	3.0	16.2	6.
12.47	4.0	1.7	58.8	6.76	4 0	9.5	10.
11.47	5.0	0.4	250.0	5.76	5.0	5.0	20.
....	....	....	....	4.76	6.0	2 4	41.
....	....	....	....	3.76	7.0	1.1	90.

o. 32.

infall minima.

Replenishing Period.				Water Year.			
Superior limit of rainfall, in inches.	Variation from the mean rainfall, in inches.	Probability, as a per cent. of all years.	Probable interval of recurrence, years.	Superior limit of rainfall, in inches.	Variation from the mean rainfall, in inches.	Probability, as a per cent. of all years.	Probable interval of recurrence, years.
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
8.99	0.0	50.0	2.0	36.22	0.0	50.0	2.0
7.99	1.0	33.9	2.9	34.22	2.0	32.8	3.0
6.99	2.0	20.3	4.9	32.22	4.0	16.9	5.9
5.99	3.0	10.6	9.4	30 22	6.0	9.1	11.0
4.99	4.0	4.8	20.8	28.22	8.0	3.7	27.0
3.99	5.0	1.9	52.6	27.22	9.0	2.2	45 0
2.99	6.0	0.6	166.0	26.22	10.0	1.3	76.9
....	....	....	....	25.22	11.0	0.7	142.8

TABI

Probability of t

Storage Period.				Growing Period.			
Inferior limit of temperatures, in degrees.	Variation from the mean, in degrees.	Probability, as a per cent. of all years.	Probable interval of recurrence, in years.	Inferior limit of temperatures, in degrees.	Variation from the mean, in degrees.	Probability, as a per cent. of all years.	Probable interval of recurrence, in years.
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
33.7	0.0	50.0	2.0	68.6	0.0	50.0	2
34.7	1.0	39.5	2.5	69.0	0.4	35.3	2.
35.7	2 0	21.1	4.7	69.5	0.9	19 9	5.
36.7	3.0	11.5	8 7	70.0	1.4	9.4	10
37.7	4.0	5.5	18.2	70 5	1.9	3.7	[illegible]
38.7	5 0	2.2	45.4	71.0	2.4	1.2	8
39.7	6.0	0.8	125.0	71.5	2.9	0.3	31
....	....	....	....	....	....	....	....

No. 33.

perature maxima.

Replenishing Period.				Water Year.			
Inferior limit of temperatures, in degrees.	Variation from the mean, in degrees.	Probability, as a per cent. of all years.	Probable interval of recurrence, in years.	Inferior limit of temperatures, in degrees.	Variation from the mean, in degrees.	Probability, as a per cent. of all years.	Probable interval of recurrence, in years
(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
49.1	0.0	50.0	2.0	46.3	0.0	50.0	2.0
49.6	0.5	37.3	2.7	46.8	0.5	37.8	2.7
50.1	1.0	26.1	3.8	47.3	1.0	25 8	3.9
50.6	1.5	16.7	6.0	47.8	1.5	16.6	6.0
51.1	2.0	10.0	10.0	48.3	2.0	9.7	10.3
51.6	2.5	5.4	18.5	48.8	2.5	5.3	18.8
52.1	3.0	2.7	37.0	49 3	3.0	2.6	38.4
52.6	3.5	1 3	76.9	49.8	3.5	1.2	83.3

dition because rainfalls less than the mean by more than 100 per cent. are impossible; on the other hand rainfalls more than 100 per cent. greater than the mean are of frequent occurrence.

We should expect, therefore, to find in any rainfall record:

(1) More dry years than wet.

(2) Greater range of rainfall above the mean than below.

MR. BINNIE'S STUDY OF AVERAGE RAINFALL.

In an able paper on Fluctuations of Rainfall, read before the Institution of Civil Engineers, in 1892, Mr. Alexander R. Binnie, chief engineer of the London County Council, has pointed out certain fundamental principles relating to rainfall studies which we may refer to here.*

In the beginning, Mr. Binnie points out that before any progress can be made in the scientific investigation of rainfall records some way must be contrived to bring all records to the test of a common standard of comparison. Such standard he points out may be obtained by taking advantage of the well known fact that if a rainfall record be carefully kept over a sufficiently long period of years, an average of mean fall will be arrived at which will not be much altered even if the record be extended for a greater number of years.

In order to analyze a large number of records, Mr. Binnie has adopted the practice of recording the mean as unity and reducing the total fall of each year in the series to a percentage or ratio of the mean fall of the whole period comprised in any given record. Studying rainfall records in this way, it is found that there are certain general laws which apply in all parts of the world, even where there are differences as great as 100 inches of fall at one station and 10 inches fall at some other station, possibly on an entirely different part of the earth.

One of the important problems worked out by Mr. Binnie is an answer to this question—what is the least number of years of which the continuous record, when the mean rainfall has been

*On Mean or Average Annual Rainfall and the Fluctuations to Which it is Subject. By Alexander R. Binnie, M. Inst. C. E. Proc. of the Inst. C. E. vol. CIX (1892), pp. 89-172.

determined, will not be materially affected, so far as the value of the mean is concerned, even if the record be extended by a greater number of years of observation? Also, as a subhead of the main question, what is the probable accuracy of any record, the length of which is less than that necessary to give a mean which will not be materially altered even when the record is extended?

In answering this question, Mr. Binnie takes up a number of long records and divides them into periods of five years each, and by adding the means of the consecutive five-year periods, finally determines the limit of the number of years beyond which the mean will not be materially altered howsoever far the record may be carried. In order to indicate some of the results of this method of studying rainfall, we may refer to Mr. Binnie's discussion of the long record of ninety-seven years kept at Padua, Italy. The first step is to divide the record into nineteen periods of five years each, commencing with 1725, and extending to 1819.* The average ratio of each of these five-year periods was then computed. They indicate that there were eight periods, viz., 1730-34, 1745-49, 1750-55, 1760-64, 1765-69, 1785-89, 1759-99 and 1810-14, during which the five-year average ratio was within 5 per cent. of the mean; but this was not the object of inquiry; it was to find the greatest divergence, which was discovered in the periods of 1770-74, when the average ratio was 32 per cent. above the mean, and 1735-39, and 1815-19, when it fell 20.8 per cent. below the mean.

In dividing the total period into minor periods of ten years each, it appears that in four of the ten-year periods, 1725-34, 1745-54, 1755-84 and 1805-14, the mean of the ten-year period was within 5 per cent. of the mean of the ninety-seven year period; the extreme divergencies were in 1765-74, when the ten years' average ratio rose to 16.9 per cent. above the mean, and in 1735-44, when it fell to 17.8 per cent. below the mean. Again dividing the total period into longer periods of fifteen years each, it appears that there were periods, 1725-39, 1740-54, 1755-69 and 1785-99, during each of which the fifteen years' average ratio was within 5 per cent. of the mean, and the extreme divergences were in the period of 1770-84, when

*The Padua record is considered to be one of the best of the older long records.

the average ratio rose 10.7 per cent. above the mean, and in 1725-39, when it fell to 4.7 per cent. below. Dividing the total period into four periods of twenty years each, it was found that the average deviation from the mean was only 5.4 per cent. and that the extreme differences in the twenty years' period were in 1765-84, and 1725-44, when they amounted to 8.5 per cent. above, and 7.2 per cent. below, respectively. For twenty-five year periods the ratios show an average deviation from the mean of 5.8 per cent., the extreme being in the periods 1750-74, 1725-49, when they were respectively 9.9 per cent. above and 4.9 per cent. below the mean. Taking thirty-year periods, the ratios show an average deviation of 4.4 per cent. from the mean, the extreme, in 1755-84, rising 7.9 per cent. above, and in 1725-55 falling 3.7 per cent. below the mean. For thirty-five year periods, the ratios gave 1.7 per cent. below and 3.3 above the mean, respectively. For forty-year periods, the divergencies are 4.8 per cent. above and 1.1 per cent. below. Finally, for forty-five year periods, the deviations are 4.5 per cent. above and 0.8 per cent. below.*

In order to obtain two fifty-year periods from the ninety-seven years' record, it is necessary that one record overlap the other. This, however, Mr. Binnie considers justifiable, because the object is not to obtain the actual fall of rain, but an arbitrary period to compare with the mean. On this basis, taking two fifty-year periods, from 1725 to 1774, and from 1770 to 1819, we deduce divergencies from the mean of 2.3 per cent. and an extreme difference of 2.5 per cent.

Summing up the results of the inquiry as to the deviations of the Padua record, Mr. Binnie points out that an average based on only a five-year record might be subject to an error of 32 per cent.; an average based on a ten-year record, to an error of 7.7 per cent; on a twenty-year record, an error of 7.8 per cent.; twenty-five-year record, an error of 5.8 per cent.; thirty-five year record, an error of 2.5 per cent.; forty-year record, an error of 2.9 per cent.; forty-five-

*In the foregoing abstract the minor subdivisions of the entire period have not been included.

year record, an error of 2.6 per cent., and a fifty-year record to an error of 2.5 per cent.

Proceeding on these lines, Mr. Binnie has examined a number of rainfall records from various parts of the world. He concludes that with any good record of thirty-five years' length and upward the mean thereof will represent the true mean rainfall within about 2 per cent., and that not much greater accuracy than this can be expected even when the record is extended to a longer period.

As illustrating how thoroughly rainfall records respond to the general law here announced, Mr. Binnie points out that a long record from St. Pierre, in the West Indies, where there is a mean rainfall of 94.13 inches, compares well with Prague, which has a mean rainfall of only 16.10 inches.

Among others, Mr. Binnie gives a tabulation of twenty-six records, ranging from fifty to fifty-nine years in length and covering stations in various parts of the world, but all included within the present century. Some of the deductions from the twenty-six records of the present century are as follows: The probable error for a five years' period is 14.95 per cent., correct within 4.21 per cent.; for a ten years' period, 8.22 per cent., correct within 2.54 per cent.; for a fifteen years' period, 4.75 per cent., correct within 2.14 per cent.; for a twenty years' period, 3.24 per cent., correct within 1.51 per cent.; for a twenty-five years' period, 2.75 per cent., correct within 1.99 per cent.; for a thirty years' period, 1.78 per cent., correct within 1.1 per cent.

Mr. Binnie also points out that as the result of working out the twenty-six present century records, it can be said that for records of from 20 years to 35 years, the error may be expected to vary from 3.25 per cent. down to 2 per cent., and for shorter periods of 5, 10 and 15 years the probable extreme deviation from the mean will be about 15.0, 8.25 and 4.75 per cent. respectively. No particular significance should be attached to a period of 35 years for it means no more than that it is the first in a series of arbitrary periods, advancing by 5 years at a time, which would appear to comply with the requirements sought for, namely: What is the shortest period, the

average of which will give a mean annual rainfall which will not be materially altered if the record be prolonged?

MORE DRY YEARS THAN WET.

As applying to the proposition that we should expect to find in any record more dry years than wet and a greater range of rainfall above the mean than below, it may be cited that Mr. Binnie found in 153 long rainfall records, representing 6,990 yearly observations that the average percentages of years below and above the mean were 47.1 and 52.9 respectively.

The Albany 70-year record contains 34 years of high and 36 years of low rainfall. The combined Albany, Glens Falls and Keene valley, 17-year record, as given in Table No. 26, contains 7 years of high and 10 years of low rainfall.

THE APPLICATION OF THE LAW OF ERROR.

Table No. 29, contains a comparison of a number of computed and observed residuals of a given value in the Albany 70-year record and the combined 17 years Albany, Glens Falls and Keene valley record. In estimating the value of the results in Table No. 29, the relative length of the series should be taken into account. Also the fact that rainfall data are subject to purely accidental errors often of no small magnitude. In any case the results deduced by the theory of probabilities should be taken in connection with all the other knowledge of the subject in hand. For reliable records of sufficient length in which the number of dry years does not greatly exceed the number of wet years there seems to be no reason why the Gaussian law of error may not be applied to deduce the probable rainfall, and the results, be reliable within the limits of our requirements; although, owing to the fact that there are more dry than wet years on an average, the computed number of low rainfall years will be slightly too large. This fact, however, has no other significance than that the error due to applying the Gaussian law in determining probable rainfall is fortunately on the safe side.

In order to apply the method of least squares where several re-

cords are combined to represent the entire watershed it is essential that the records used should be cotemporaneous and of equal length. In the present case, the best available records answering this condition are the Albany, Glens Falls and Keene valley rainfall and temperature records, combined means of which are shown in Tables Nos. 26 and 27.

VARIABILITY OF THE RAINFALL.

The variability or probable fluctuation of a single year's observed rainfall from the mean, also the precision of the Albany, Glens Falls and Keene valley rainfall records is shown in Table No. 30. The variability and precision of various other rainfall records of about the same length are also shown therein for comparison.*

The Hudson records show rather a low variability and, on the whole, an unusual precision of the mean for records of this length.

Binnie gives 4.2 per cent. of the rainfall as the average error or variability for a seventeen-year record. This would be 1.57 inches for Albany, 1.52 inches for Glens Falls, 1.48 inches for Keene valley. These probable errors are found by subtracting the mean rainfall of all the dry years from the mean rainfall of all the years, and so differ from the factors given in Table No. 30. Either, however, may be used as a measure of the variability or tendency of the rainfall to fluctuate from year to year.

GENERAL METEOROLOGICAL CHARACTERISTICS OF THE WATERSHED.

In Table No. 31, we have the general meteorological characteristics of the Upper Hudson watershed. The maximum and minimum monthly temperatures therein appearing have been derived from Table No. 27; also the variability which it will be seen is much greater for single months than for the entire year. The rainfall data are from Table No. 26. The monthly variability is about 30 per cent. of the monthly rainfall, while for the year it is only 8.4 per cent. of the rainfall. The runoff data are from Table No. 6 of the 1895 report, with the Mechanicville record of 1896 included. The

*Taken from the Smithsonian Contributions to Knowledge. Vol. XIV, p. 215.

greatest variability and runoff both in amount and per cent. occurs in May.

PROBABLE RAINFALL AND TEMPERATURE.

Tables Nos. 32 and 33 have been computed from the combined Albany, Glens Falls and Keene valley records, as given in Tables Nos. 26 and 27. The probable percentage of years having a rainfall below any given per cent. of the mean is shown in the third column of the periods of each table, and the probable average frequency of recurrence of such a minimum, in years, is shown in the fourth column of each period.

The probable percentage of years and interval of recurrence of years having a temperature above the given maximum are likewise shown in Table No. 33.

The minimum observed rainfalls and maximum temperatures for seventeen years are shown in Table No. 34, together with the intervals in which they may be expected to recur. This table emphasizes the fact that the maximum or minimum occurring in any record may probably be repeated sometimes at much longer and sometimes at much shorter intervals in future years, according to the variability of the rainfall or temperature, whichever it may be.

From Table No. 32 we may readily find a minimum rainfall which may not be expected to recur oftener than at any specified interval. This table suggests a method by which a more consistent minimum rainfall may be obtained than by merely assuming the minimum observed in any record which, as has been shown, may occur at much shorter intervals in future years. We may also conclude that the application of the method of least squares to a rainfall record in this way practically extends the record to an infinite series, in which the precision of the mean of the record will be inversely proportional to the square root of the number of years included. Hence probable rainfalls, as ordinarily deduced from short series and outside the range occurring in the record itself, can only be relied upon within comparatively narrow limits.

DO YEARS OR PERIODS HAVING HIGH TEMPERATURES AND HEAVY RAINFALL TEND TO CONCUR?

Before applying Tables Nos. 31, 32 and 33 to find the probability of drier years than 1891-95, certain questions must be examined in order to clear the ground. In the first place, high temperature, as an accompanying condition of frequent thunder storms, would indicate that in the summer months, at least, high temperature and heavy rainfall probably run parallel, and conversely. To settle the question as far as possible for the present study, the cotemporaneous rainfall and temperature records included in Tables Nos. 24 and 25 have been examined and the results brought together in Table No. 35. In 82 out of 160 years, rainfall and temperature conditions are found to be alike in the growing period. In accordance with the theory of chance the two should correspond in fifty per cent. of the years. A study of the records of the storage and replenishing periods of an entire water year shows similar results.

On the whole, then, it may be said that the records now under consideration indicate that the concurrence or non-concurrence of like conditions of temperature and rainfall is a matter of pure chance. It is not intended to say absolutely that rainfall and temperature are independent, but that for the purposes of the present study they may be considered to be so. We may say, however, the study indicates that, so far as the Hudson area is concerned, probably there is no direct relation between rainfall and temperature.

TABLE No. 34.

Probability of the recurrence of the observed maxima and minima.

PERIOD.	PRECIPITATION.		TEMPERATURE.	
	Minimum.	Probable interval of years.	Maximum.	Probable interval of years.
Storage	13.14	31.4	37.1	12.5
Growing	6 94	9.7	70 5	27.0
Replenishing	5.99	9 4	50.8	6.8
Water year	29.91	18.4	48.3	10.3

SEQUENCE OF DRY YEARS AND TENDENCY OF YEARS OF LOW RAINFALL TO RUN IN SHORT SERIES.

The Hudson watershed, having an area of 4,500 square miles above Mechanicville, and with a wide range of topographical conditions, contains distinct regions in which entirely different meteorological conditions prevail, produced by the operation of distinctly different causes. Comparing the cotemporaneous records of Albany, Glens Falls and Keene valley, we find that in fourteen years out of seventeen, or in eighty per cent. of the years from 1879 to 1895, inclusive, high or low rainfall at Glens Falls is accompanied by a like condition at Keene valley, and similarly for temperature. In only eight out of seventeen years, however, are the rainfalls both higher or both lower than the mean at Albany and Keene valley. By the theory of chance, conditions would be like in fifty per cent. of the years if the recurrence of like conditions at the two stations were purely accidental. Hence we may say at once that while Keene valley and Glens Falls belong to the same region, meteorologically considered there is no relation between the conditions controlling rainfall in the Albany region as compared with the Adirondack region. With a sufficient number of cotemporaneous records the entire watershed could in this way readily be charted into what might be termed isoclimatic areas, in which the meteorological conditions might be expected to correspond closely.

The effect of the runoff of several such sub-areas being included in one watershed would be to equalize local extremes and give a more uniform runoff for the whole than if the entire watershed were subject to the same controlling conditions. Extremes of rainfall or runoff will, in general, be caused by general modifying conditions affecting the entire watershed. The danger of relying too much on single records or even on the records belonging to a single climatic area is therefore made evident.

It is difficult to say whether we should expect the recurrence of short dry periods to be more frequent for a single climatic area or for the entire watershed. The data at hand do not give any definite conclusion on this point.

The Albany seventeen-year record contains three dry periods of three years each, one wet period of five years and one of two years.

The Glens Falls seventeen-year record shows one wet period of seven years and one dry period of six years.

The Keene valley seventeen-year record contains one dry period of six years, one wet period of three years and two of two years.

The foregoing three records combined show one wet period of six years and one dry period of the same length; also, two dry periods of two years.

The Albany seventy-year record contains five two-year periods, three wet and two dry; two dry periods of three years; five four-year periods, four wet and one dry, and one dry period of eight years.

The mean rainfall of the eight-year driest period in the Albany record is 35.97 inches, or 91 per cent. of the mean, the period being from 1880 to 1887, inclusive.

The mean rainfall for the three driest successive years, 1893--95, is 32.8 inches, or slightly above 80 per cent. of the mean.

The mean rainfall of the driest two successive years, 1880--81, is 32.21 inches or 80 per cent. of the mean.

TABLE No. 35.

Correspondence of precipitation and temperature in the growing period.

PLACE.	Number of years' record.	Number of years having precipitation and temperature of growing period both above or both below the mean.
Fairfield Academy	17	7
Cambridge Academy	13	8
Johnstown Academy	15	9
Lowville Academy	18	6
Granville Academy	15	6
Keene valley	17	13
Glens Falls	17	7
Albany	17	8
Albany	31	18
Total	160	82

In each of the foregoing records the minimum observed yearly rainfall occurs in one of the longer dry periods.

The average number of low rainfall years occurring together is from two to three. If the occurrence of two or more successive years of high or low rainfall were purely a matter of chance, then the probable frequency of occurrence of a period of n years of low rainfall would be $\frac{1}{2}\left[\frac{a}{a+b}\right]^n$ a, being the number of dry years in the record, and b the number of wet years. Assuming that a equals b, the chance and frequency of occurrence of dry periods of different lengths would be as follows:

1. Two successive dry years may be expected 12.5 times in 100 years.
2. Three successive dry years may be expected 6.5 times in 100 years.
3. Four successive dry years may be expected 3.12 times in 100 years.
4. Five successive dry years may be expected 1.4 times in 100 years.
5. Six successive dry years may be expected 0.7 times in 100 years, or once in 143 years.

The occurrence of several five and six-year periods in the seventeen-year records shows that the sequence of wet and dry years is not a matter of chance, although the periods themselves show no uniformity or tendency to run at uniform intervals. In the foregoing records, dry periods of from two to eight successive years occur from two to three times as frequently as if their occurrence were controlled by mere chance, the ratio slightly increasing with the length of the dry period.

PROBABILITY OF THE OCCURRENCE OF A YEAR COMPOSED OF MINIMUM RUNOFF MONTHS.

The minimum observed monthly runoffs at Mechanicville, together with the means for the same months are given in Table No. 36, where we also have the minimum monthly rainfalls in the Albany seventy-year record. The probability of runoffs lower than

the sum of the monthly minima has been computed directly from Table No. 36, and the results, together with the observed minima and nine-year means are shown for each period in Table No. 37.

TABLE No. 36.

Minimum monthly runoff and precipitation.

MONTH.	NINE-YEAR RUNOFF RECORD.			ALBANY 70-YEAR PRECIPITATION RECORD.		
	Y ar.	Minimum.	Mean.	Year.	Minimum.	Per cent. of mean.
		Inches.	Inches.		Inches.	
December	1891	0.83	1.99	1829	0.24	11.3
January	1893	0.82	2.17	1860	0.08	3.4
February	1895	0.82	1.41	1856 / 1877	0.36	14.2
March	1895	1.08	2.78	1855	0.54	19.8
April	1894	2.76	4.67	1892	0.56	20.0
May	1896	1.18	3.26	1826	0.76	20.9
Storage period	1895	11.68	16.23	1860	7.18	42.0
June	1895	0.70	1.50	1864	0.80	19.6
July	1888	0.39	0.91	1849	0.70	16.3
August	1888	0.44	0.85	1876	0.53	13.4
Growing period	1888	2.05	3.26	1886	6.62	54.0
September	1894	0.47	0.95	1871	0.85	24.7
October	1891	0.38	1.08	1882	0.27	7.5
November	1893	0.90	1.90	1893	0.91	29.5
Replenishing period	1891	1.90	3.88	1892	4.97	49.2
Water year	1895	17.46	23.37	1864	28.13	71.3

By this method a final minimum is obtained for the storage runoff having a probable interval of recurrence of 166 years.

For the growing period the probable frequency is much greater, the interval of recurrence being 48.7 years, and for the replenishing period it is 21.7 years. For the entire water year it is fifty-four years. In selecting the final minimum runoff as a standard of comparison, it would seem proper to give the same probable interval of recurrence to each period.

As the length of the series of gagings increases the minimum of the observed runoffs will slightly decrease toward a limit.

From Table No. 31 the percentage of variability of the monthly runoffs is seen to be generally greater than that of the different periods or of the yearly runoff. Hence, as the length of record

increases the sum of the minimum monthly runoffs will decrease, such decrease taking place more rapidly than the minimum yearly runoff, until it becomes less than any yearly runoff which may be expected to occur. The same principle holds good for rainfall minima; to illustrate this we may use the Albany seventy-year record, the monthly minima of which are given in Table No. 36.

TABLE No. 37.

Probability of runoffs lower than the sum of minimum observed monthly runoffs.

PERIOD.	Nine year mean.	Observed minimum.	Sum of minimum months.	Probable per cent. of lower run-off years.	Interval of recurrence of lower runoff years.
	Inches.	Inches.	Inches.		
Storage	16.23	11.68	7.49	0.60	166.0
Growing	3.26	2.05	1.53	2.05	48.7
Replenishing	3.88	1.90	1.75	4.60	21.7
Water year	23.37	17.46	10.77	1.85	54.0

The sums of the monthly minima, together with the observed minima and means, are given in Table No. 38. For the different periods the sums of the minimum months vary from 14.8 to 20 per cent. of the mean rainfalls for the same period. It is not within the capacity of the most extensive tables of probability at hand to compute the chance of so low rainfalls ever occurring. Out of 150 long rainfall records, representing 6,990 annual observations examined by Mr. Binnie only three showed minima below 40 per cent. of the mean.

PROBABILITY OF DRIER YEARS THAN 1891 AND 1895.

The data of these two years have been collected in Table No. 39. The temperatures are from Table No. 27, and the rainfalls from Table No. 26.

From the Upper Hudson report for 1895, we learn, at page 112, that in 1891 there occurred a dry period of 174 days, lasting from May 28th to November 17th. In 1895 the dry period began May 25th and lasted until November 9th, continuing 169 days.

The causes contributing toward a dry year are:

1. Minimum rainfall.
2. Unfavorable distribution of rainfall.
3. High temperature.
4. Unfavorable distribution of temperature.

In 1891 the temperature was normal and favorable to good stream flow. Nor can the dry period be attributed to low rainfall. The storage runoff is sufficient to ensure full ground water May 1st. The growing period rainfall was above the mean. The May rainfall, however, was but 1.91 inches, as shown in Table No. 26, 60.8 per cent. of the mean; and the September rainfall is but 1.44 inches or 46 per cent. of the mean. The dry period of 1891 is, therefore, to be attributed to the unfavorable distribution of the rainfall. With the exception of 1887, the September rainfall in 1891 is the lowest in the seventeen-year record; with the exception of 1879 and 1887, the May rainfall was the lowest in seventeen years. These facts point to a similar dry period in 1879 and 1887.

TABLE No. 38.

Sum of minimum rainfall months in the Albany 70-year record.

PERIOD.	70-year mean.	Sum of Minimum Months.		Observed Minimum.	
		Inches.	Per cent. of mean.	Inches.	Per cent. of mean.
Storage	17.09	2.54	14.8	7.18	42
Growing	12.32	2.03	18.6	6.62	54
Replenishing	10 09	2.03	20.0	4.97	49
Water year	39.50	6.60	16.8	28.18	71

The computed probable interval of recurrence of a May rainfall as low as that in 1891 is five years.

The computed probable interval of recurrence of a September rainfall as low as that of 1891 is twelve years.

Theoretically, the probability of these two minima occurring in a single year will be the product of their respective probabilities, thus giving roundly sixty years as the average interval of recurrence of such a dry period.

During the year 1891, however, temperature and other conditions were either normal or favorable to a good stream yield. We must then assume a somewhat shorter interval of dry periods as severe as that in 1891, or else that still more severe periods will sometimes occur when temperature conditions are unfavorable.

In 1895, the storage rainfall was slightly below the mean, but ground water was probably nearly full on June 1, the May rainfall being 1.98 inches or 63 per cent. of the mean.

The storage temperature was 1° above the mean, and that of the growing period, 1.7°.

TABLE No. 39.

Temperature and precipitation data for the years 1891 *and* 1895.

PERIOD.	1891.		1895.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	F°.	Inches.	F°.	Inches.
Storage	34.0	18.90	34.4	13.14
Growing	68.4	11.89	70.3	12.18
Replenishing	50.8	6.78	50.1	9.27
Water year	46.8	37.57	47.3	34.59

It is not as easy to compute the probable frequency of such a dry year as 1896, as in the case of 1891. Doubtless the unfavorable distribution of the rainfall and the high growing period temperature contributed most largely to cause the dry period. From Table No. 31, it is learned that a growing period temperature as high as that in 1895, may not be expected oftener than once in twenty years.

The foregoing presents the more important points of the relation of rainfall, temperature and runoff, with the practical deductions therefrom which may be safely drawn from the available data. In some future report it is intended to discuss, as the final theoretical question, the method of deducing a formula enabling one to take the rainfall and temperature records of a long series of years and deduce therefrom the probable yearly runoffs of a stream. It has been found impossible to prepare the discussion under this head in time for the present report.

A re-reading of the 1895 report shows a number of errors either of the printer or computer in the tables, as well as a few such in descriptive matter. Inasmuch as the yearly reports are progress reports merely, it has been thought best not to attempt the correction of the mere numerical errors at this time, but an attempt will be made in the final report to give all the data as correctly as possible. A correction of formula (3) on page 105 may, however, be given. That formula should read:

$$C = 1 - \left(\frac{0.04\,[34.6 + d]}{4}\right)$$

A originally printed the (1—) had been dropped out.

In referring to computer's errors in the foregoing there is no intention or desire to reflect in any way upon my assistants. All have been willing and active within the scope of their attainments, though it may be said that the State system of appointments fails in some cases to furnish men of just the qualifications for special work. Especially is this true where a mass of statistics is to be handled. I desire to say, however, that all my assistants have been willing, and in no case can the few errors found be ascribed to intention. In any case some of them are probably my own.

My thanks are due to Foster B. Morse, C. E., who had charge of the field work during the season of 1896.

The tables accompanying the discussion of the law of probability, etc., in its application to rainfall records have been prepared by Mr. Robert E. Horton, of Albion College, Albion, Michigan, as a contribution to the survey. My thanks are especially due to him for the large amount of labor which he has performed in computing the said tables.

Wallace Greenalch, C. E., has also assisted in computing the other tables of the report.

Very respectfully,

GEO. W. RAFTER,

Engineer in Charge.

INDEX.

A

B

C

D

E

F

G

H

I

L